



See the light - agile, industrial strength, rapid web application development made easy

The Grails Framework - Reference Documentation

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1 Introduction

Java web development as it stands today is dramatically more complicated than it needs to be. Most modern frameworks are complicated and don't embrace the Don't Repeat Yourself (DRY) principles.

Dynamic frameworks like Rails, Django and TurboGears helped pave the way to a more modern way of thinking about these concepts and dramatically reduces the complexity of building web applications on the Java platform. Grails does so by building on already established Java technologies like Spring and Hibernate.

Grails is a full stack framework and attempts to solve as many pieces of the web development puzzle as possible. Included out of the box are things like:

- An easy to use Object Relational Mapping (ORM) layer built on [Hibernate](#)
- An expressive view technology called Groovy Server Pages (GSP)
- A controller layer built on [Spring](#) MVC
- An interactive command line environment and build system based on [Gradle](#)
- An embedded [Tomcat](#) container which is configured for on the fly reloading
- Dependency injection with the inbuilt Spring container
- Support for internationalization (i18n) built on Spring's core MessageSource concept
- A transactional service layer built on Spring's transaction abstraction

All of these are made easy to use through the power of the [Groovy](#) language and the extensive use of Domain Specific Languages. This documentation will take you through getting started with Grails and building web applications with them.

1.1 What's new in Grails 3.1?

Grails 3.1 includes the following new features.

Spring Boot 1.3 and Spring 4.2

Grails 3.1 has been upgraded to Spring Boot 1.3 and Spring 4.2.

1.1.1 Improvements to Grails 3 Profiles

Profile Publishing and Repositories

The following improvements are available in Grails profiles:

- Profiles are now published as regular JAR files to any Maven compatible repository (Artifactory, Nexus, etc.)
- Additional profiles can be created easily with the new [create-profile](#) command.
- Profiles can now contribute to the generation of the build script
- Profiles can now have one or many features

For more information see the new [section on Profiles](#) in the user guide.

1.1.2 REST API and AngularJS Profiles

REST Profile

A new profile is available designed for the creation of pure REST applications without a UI.

To create a REST application use the `rest-api` profile as an argument to [create-app](#):

```
$ grails create-app myapp --profile=rest-api
```



In earlier milestones this profile was named `web-api`. The profile has been renamed `rest-api` to better describe its purpose.

Then start interactive mode to see the available commands for the profile:

```
$ cd myapp
$ grails
```

If you hit TAB you will notice code generation commands specific to the profile including:

- `create-domain-resource` - Creates a domain class annotated with the [Resource](#) annotation)
- `create-restful-controller` - Creates a controller that extends [RestfulController](#).

JSON and Markup Views

The REST profile includes the ability to define [JSON and Markup views](#) and the `build.gradle` for production use.

The REST profile also creates [JSON views](#) to render the `index` action and common commands such as `grails` JSON views.

AngularJS Profile

An initial version of the AngularJS profile is now available, making it easier to create and integrate AngularJS.

To create a Grails 3 AngularJS application use the `angular` profile as an argument to [create-app](#):

```
$ grails create-app myapp --profile=angular
```

Then start interactive mode to see the available commands for the profile:

```
$ cd myapp  
$ grails
```

You will notice new commands such as `create-ng-component`, `create-ng-controller` etc. application.

The `build.gradle` is also preconfigured with the necessary Gradle plugins to integrate Angular application can be found in `grails-app/assets/javascripts`.

1.1.3 GORM 5 Suite

Grails 3.1 ships with [GORM 5](#) which is a brand new release of GORM supporting the following technolog

- Hibernate 3, 4 and 5 - for SQL databases GORM for Hibernate now supports the latest Hibernate 5.x
- MongoDB 3.x - GORM for MongoDB has been upgraded to the MongoDB 3.x Java driver and support
- Neo4j 2.3.x - GORM for Neo4j has been significantly improved and support the latest release of Neo4j
- Cassandra - GORM for Cassandra supports the latest 2.0.x drivers

For more information refer to the new [GORM 5 website](#).

1.1.4 Plugin Publishing Plugins

New Gradle plugins are available to simplify publishing of plugins and profiles.

To utilize the plugin apply the `org.grails.grails-plugin-publish` plugin (after any existing C

```
apply plugin: "org.grails.grails-plugin"  
apply plugin: "org.grails.grails-plugin-publish"
```

For a profile the `grails-profile-publish` plugin can be used instead:

```
apply plugin: "org.grails.grails-profile"
apply plugin: "org.grails.grails-profile-publish"
```

Then configure the plugin. For example:

```
grailsPublish {
    user = 'user'
    key = 'key'
    githubSlug = 'foo/bar'
    license {
        name = 'Apache-2.0'
    }
    title = "My Plugin Title"
    desc = "My Plugin Description"
    developers = [johndoe:"John Doe"]
}
```

The user and key are your Bintray credentials. With this done you can continue to use `bintrayUp1` wish to update the Grails plugin portal, you simply need to configure your `grails.org` credentials:

```
grailsPublish {
    ...
    portalUser = "... "
    portalPassword = "... "
}
```

Then call `notifyPluginPortal` to update the [Grails.org Plugins website](#):

```
gradle notifyPluginPortal
```

1.2 What's new in Grails 3.0?

This section covers the new features that are present in 3.0 and is broken down into sections covering persistence enhancements and improvements in testing. Note there are many more small enhancements and of the highlights.

1.2.1 Core Features

Groovy 2.4

Grails 3.0 comes with Groovy 2.4 which includes many new features and enhancements.

For more information on Groovy 2.4, see the [release notes](#) for more information.

Spring 4.1 and Spring Boot 1.2

Grails 3.0 comes with Spring 4.1 which includes [many new features and enhancements](#).

In addition, Grails 3.0 is built on [Spring Boot 1.2](#) which provides the ability to produce runnable JAR f containers.

Gradle Build System

Grails 3.0 deprecates the older Gant-based build system in favour of a new [Gradle-based](#) build that integra

See the new section on the new [Gradle build](#) for more information.

Application Profiles

Grails 3.0 supports the notion of application profiles via a new [profile repository](#). A profile encapsula plugins and capabilities. For example the "web" profile allows construction of web applications deploy profiles will be developed targeting different environments.

See the new section on [Profiles](#) for more information.

Redesigned API based on Traits

The Grails API has been redesigned so that public API is correctly populated under the `grails.` packa change can be found in the `org.grails.` package. The core API has also been rewritten and based arou

See the new documentation on Grails 3.0's [core traits](#) for more information.

1.2.2 Web Features

New Interceptors API

In previous versions of Grails, filters were used to define logic that intercepts controller action execution.

As of Grails 3.0, this API is deprecated and has been replaced by the new [Interceptor API](#). An example int

```

class MyInterceptor {
    boolean before() { true }
    boolean after() { true }
    void afterView() {
        // no-op
    }
}

```

1.2.3 Development Environment Features

New Shell and Code Generation API

Replacing Gant, Grails 3.0 features a new interactive command line shell that integrates closely with Gradle to interact with Gradle and perform code generation.

The new shell integrates closely with the concept of application profiles with each profile capable of defining versions of Grails, plugins can define new shell commands that can invoke Gradle or perform code generation.

See the new guide on [Creating Custom Scripts](#) for more information.

Enhanced IDE Integration

Since Grails 3.0 is built on Gradle, you can now import a Grails project using IntelliJ community edition without the need for Grails specific tooling. Grails 3.0 plugins are published as simple JAR files greatly reducing the size of Grails.

Application Main Class

Each new Grails 3.0 project features an `Application` class that has a traditional `static void main` method. For a 3.0 application from an IDE like IntelliJ or GGTS you can simply right-click on the `Application` class to run it. Grails 3.0 tests can also just be run from the IDE directly without needing to resort to the command line (e.g. `gradle test`).

1.2.4 Testing Features

Integration and Geb Functional Tests

Grails 3.0 has built in support for Spock/Geb functional tests using the [create-functional-test](#) command. This command creates a test running mechanism and loads the application just once for an entire suite of tests. The tests can be run from the command line.

Gradle Test Running

Since Grails 3.0 is built on Gradle the test execution configuration is much more flexible and can easily be customized.

2 Getting Started

2.1 Installation Requirements

Before installing Grails 3.0 you will need as a minimum a Java Development Kit (JDK) installed version 1.6 or later on your operating system, run the installer, and then set up an environment variable called `JAVA_HOME` pointing to the location of Java.

To automate the installation of Grails we recommend [SDKMAN](#) which greatly simplifies installing and managing multiple versions of Grails.

For manual installation, we recommend the video installation guides from [grailsexample.net](#):

- [Windows](#)
- [Linux](#)
- [Mac OS X](#)

These will show you how to install Grails too, not just the JDK.



A JDK is required in your Grails development environment. A JRE is not sufficient.

On some platforms (for example OS X) the Java installation is automatically detected. However in many cases you may need to set the location of Java. For example:

```
export JAVA_HOME=/Library/Java/Home
export PATH="$PATH:$JAVA_HOME/bin"
```

if you're using bash or another variant of the Bourne Shell.

2.2 Downloading and Installing

The first step to getting up and running with Grails is to install the distribution.

The best way to install Grails on *nix systems is with [SDKMAN](#) which greatly simplifies installing and managing multiple versions of Grails.

For manual installation follow these steps:

- [Download](#) a binary distribution of Grails and extract the resulting zip file to a location of your choice
- Set the `GRAILS_HOME` environment variable to the location where you extracted the zip
 - On Unix/Linux based systems this is typically a matter of adding `GRAILS_HOME=/path/to/grails` to your profile
 - On Windows this is typically a matter of setting an environment variable under My Computer
- Then add the `bin` directory to your `PATH` variable:
 - On Unix/Linux based systems this can be done by adding `export PATH="$PATH:$GRAILS_HOME/bin"`
 - On Windows this is done by modifying the `Path` environment variable under My Computer

If Grails is working correctly you should now be able to type `grails -version` in the terminal window and see:

```
bc. Grails version: 3.0.0
```

2.3 Creating an Application

To create a Grails application you first need to familiarize yourself with the usage of the `grails` command.

```
grails [command name]
```

Run [create-app](#) to create an application:

```
grails create-app helloworld
```

This will create a new directory inside the current one that contains the project. Navigate to this directory in the terminal window:

```
cd helloworld
```

2.4 A Hello World Example

Let's now take the new project and turn it into the classic "Hello world!" example. First, change into the 'helloworld' directory in the Grails interactive console:


```
$ cd helloworld
$ grails
```

You should see a prompt that looks like this:

```
Graeme-Rochers-iMac:helloworld graemerocher$ grails
! Enter a script name to run. Use TAB for completion:
grails>
story created in the previous section and activate interactive mode:
```

What we want is a simple page that just prints the message "Hello World!" to the browser. In Grails, when we have a controller action for it. Since we don't yet have a controller, let's create one now with the [create-controller](#) command.

```
grails> create-controller hello
```

Don't forget that in the interactive console, we have auto-completion on command names. So you can type `create-*` commands. Type a few more letters of the command name and then `<tab>` again to finish.

The above command will create a new [controller](#) in the `grails-app/controllers` directory. Why the extra `helloworld` directory? Because in Java land, it's strong packages, so Grails defaults to the application name if you don't provide one. The reference page for [create-controller](#) has more details.

We now have a controller so let's add an action to generate the "Hello World!" page. The code looks like this:

```
package helloworld

class HelloController {
    def index() {
        render "Hello World!"
    }
}
```

The action is simply a method. In this particular case, it calls a special method provided by Grails to [render](#) a response. Job done. To see your application in action, you just need to start up a server with another command called `run-app`.

```
grails> run-app
```

This will start an embedded server on port 8080 that hosts your application. You should now be <http://localhost:8080/> - try it!

Note that in previous versions of Grails the context path was by default the name of the application. If you a context path in `grails-app/conf/application.yml`:

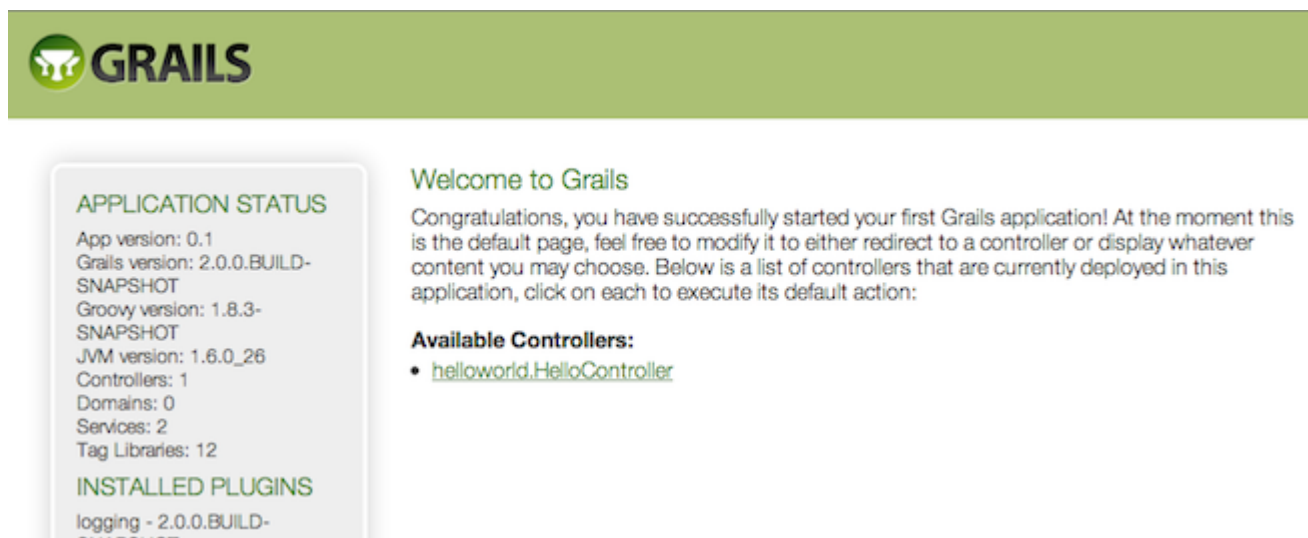
```
server:
  'contextPath': '/helloworld'
```

With the above configuration in place the server will instead startup at the URL <http://localhost:8080/hello>



If you see the error "Server failed to start for port 8080: Address already in use", then it mean that port. You can easily work around this by running your server on a different port using '9090' is just an example: you can pretty much choose anything within the range 1024 to 4915

The result will look something like this:

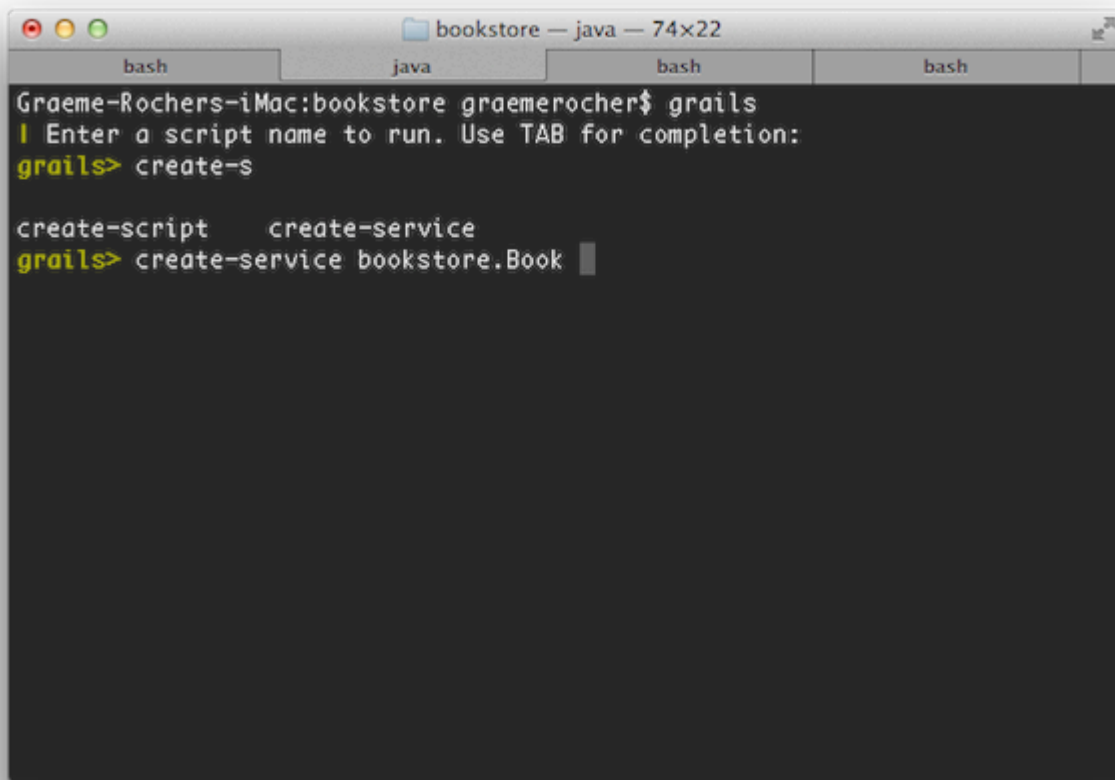


This is the Grails intro page which is rendered by the `grails-app/view/index.gsp` file. It detect links to them. You can click on the "HelloController" link to see our custom page containing the text "Hel Grails application.

One final thing: a controller can contain many actions, each of which corresponds to a different page accessible via a unique URL that is composed from the controller name and the action name: `/<appname/<controller/<action`. To access the Hello World page via [/helloworld/hello/index](http://localhost:8080/helloworld/hello/index), where 'hello' is the controller name (remove lower-case the first letter) and 'index' is the action name. But you can also access the page via the same 'index' is the *default action*. See the end of the [controllers and actions](#) section of the user guide to find out

2.5 Using Interactive Mode

Grails 3.0 features an interactive mode which makes command execution faster since the JVM doesn't interactive mode simple type 'grails' from the root of any projects and use TAB completion to get a list of for an example:

A screenshot of a terminal window titled 'bookstore — java — 74x22'. The window has four tabs labeled 'bash', 'java', 'bash', and 'bash'. The terminal shows the following commands and output:

```
Graeme-Rochers-iMac:bookstore graemerocher$ grails
! Enter a script name to run. Use TAB for completion:
grails> create-s

create-script      create-service
grails> create-service bookstore.Book
```

For more information on the capabilities of interactive mode refer to the section on [Interactive Mode](#) in the

2.6 Getting Set Up in an IDE

IntelliJ IDEA

[IntelliJ IDEA](#) is an excellent IDE for Grails 3.0 development. It comes in 2 editions, the free community edition and the commercial edition.

The community edition can be used for most things, although GSP syntax highlighting is only part of the full IDE. To get started with Grails 3.0 simply go to `File / Import Project` and point IDEA at your `build.gradle` file.

Eclipse

We recommend that users of [Eclipse](#) looking to develop Grails application take a look at [Groovy/Grails Tooling](#) including automatic classpath management, a GSP editor and quick access to Grails commands.

Like IntelliJ you can import a Grails 3.0 project using the Gradle project integration.

NetBeans

NetBeans provides a Groovy/Grails plugin that automatically recognizes Grails projects and provides the IDE with code completion and integration with the Glassfish server. For an overview of features see the [NetBeans IDE for Grails](#) was written by the NetBeans team.

TextMate, Sublime, VIM etc.

There are several excellent text editors that work nicely with Groovy and Grails. See below for references:

- A [TextMate bundle](#) exists Groovy / Grails support in [Textmate](#)
- A [Sublime Text plugin](#) can be installed via Sublime Package Control for the [Sublime Text Editor](#).
- See [this post](#) for some helpful tips on how to setup VIM as your Grails editor of choice.
- An [Atom Package](#) is available for use with the [Atom editor](#)

2.7 Convention over Configuration

Grails uses "convention over configuration" to configure itself. This typically means that the name a configuration, hence you need to familiarize yourself with the directory structure provided by Grails.

Here is a breakdown and links to the relevant sections:

- `grails-app` - top level directory for Groovy sources
 - `conf` - [Configuration sources](#).
 - `controllers` - [Web controllers](#) - The C in MVC.
 - `domain` - The [application domain](#).
 - `i18n` - Support for [internationalization \(i18n\)](#).
 - `services` - The [service layer](#).
 - `taglib` - [Tag libraries](#).
 - `utils` - Grails specific utilities.
 - `views` - [Groovy Server Pages](#) - The V in MVC.
- `scripts` - [Code generation scripts](#).
- `src/main/groovy` - Supporting sources
- `src/test/groovy` - [Unit and integration tests](#).

2.8 Running and Debugging an Application

Grails applications can be run with the built in Tomcat server using the [run-app](#) command which will load

```
grails run-app
```

You can specify a different port by using the `server.port` argument:

```
grails -Dserver.port=8090 run-app
```

Note that it is better to start up the application in interactive mode since a container restart is much quicker

```
$ grails
grails> run-app
| Server running. Browse to http://localhost:8080/helloworld
| Application loaded in interactive mode. Type 'stop-app' to shutdown.
| Downloading: plugins-list.xml
grails> stop-app
| Stopping Grails server
grails> run-app
| Server running. Browse to http://localhost:8080/helloworld
| Application loaded in interactive mode. Type 'stop-app' to shutdown.
| Downloading: plugins-list.xml
```

You can debug a grails app by simply right-clicking on the `Application.groovy` class in your IDE (see section 3).

Alternatively, you can run your app with the following command and then attach a remote debugger to it.

```
grails run-app --debug-jvm
```

More information on the [run-app](#) command can be found in the reference guide.

2.9 Testing an Application

The `create-*` commands in Grails automatically create unit or integration tests for you within the `src` directory. You can then populate these tests with valid test logic, information on which can be found in the section on [Testing](#).

To execute tests you run the [test-app](#) command as follows:

```
grails test-app
```

2.10 Deploying an Application

Grails applications can be deployed in a number of different ways.

If you are deploying to a traditional container (Tomcat, Jetty etc.) you can create a Web Application Archive (WAR) file using the `grails war` command for performing this task:

```
grails war
```

This will produce a WAR file under the `build/libs` directory which can then be deployed as per your container's documentation.

Note that by default Grails will include an embeddable version of Tomcat inside the WAR file, this can be disabled by using the `provided` scope for the `org.springframework.boot:spring-boot-starter-tomcat` dependency. If you don't intend to use the embedded container then you should change the scope of the dependency to `provided` in `build.gradle`:

```
provided "org.springframework.boot:spring-boot-starter-tomcat"
```

Unlike most scripts which default to the `development` environment unless overridden, the `war` command defaults to the `production` environment. You can override this like any script by specifying the environment name, for example:

```
grails dev war
```

If you prefer not to operate a separate Servlet container then you can simply run the Grails WAR file as a regular Java application using the `java` command:

```
grails war  
java -Dgrails.env=prod -jar build/libs/mywar-0.1.war
```

When deploying Grails you should always run your containers JVM with the `-server` option and with the `-XX:+UseG1GC` flag. The full set of JVM flags would be:

```
-server -Xmx768M -XX:MaxPermSize=256m
```

2.11 Supported Java EE Containers

Grails runs on any container that supports Servlet 3.0 and above and is known to work on the following sp

- Tomcat 7
- GlassFish 3 or above
- Resin 4 or above
- JBoss 6 or above
- Jetty 8 or above
- Oracle Weblogic 12c or above
- IBM WebSphere 8.0 or above



It's required to set "-Xverify:none" in "Application servers > server > Process Definition > Java VM arguments" for older versions of WebSphere. This is no longer needed for WebSphere v

Some containers have bugs however, which in most cases can be worked around. A [list of known deploym](#)

2.12 Creating Artefacts

Grails ships with a few convenience targets such as [create-controller](#), [create-domain-class](#) and so on that w for you.



These are just for your convenience and you can just as easily use an IDE or your favourite te

For example to create the basis of an application you typically need a [domain model](#):

```
grails create-app helloworld
cd helloworld
grails create-domain-class book
```

This will result in the creation of a domain class at `grails-app/domain/helloworld/Book.gro`

```
package helloworld  
  
class Book {  
}
```

There are many such `create-*` commands that can be explored in the command line reference guide.



To decrease the amount of time it takes to run Grails scripts, use the interactive mode.

2.13 Generating an Application

To get started quickly with Grails it is often useful to use a feature called [Scaffolding](#) to generate the skeleton of an application. Grails provides `generate-*` commands such as [generate-all](#), which will generate a [controller](#) (and its unit test) and the a

```
grails generate-all helloworld.Book
```


3 Upgrading from previous versions of Grails

Grails 3.0 is a complete ground up rewrite of Grails and introduces new concepts and components for many things.

When upgrading an application or plugin from Grails 3.0 there are many areas to consider including:

- Removal of dynamic scaffolding from Grails 3.0.0 till 3.0.4 when it was re-introduced
- Removal of before and after interceptors
- Project structure differences
- File location differences
- Configuration differences
- Package name differences
- Legacy Gant Scripts
- Gradle Build System
- Changes to Plugins
- Source vs Binary Plugins

The best approach to take when upgrading a plugin or application (and if your application is using several plugins) is to create a new Grails 3.0 application of the same name and copy the source files into the correct locations.

Removal of before and after interceptors

Before and after interceptors were removed. So all `beforeInterceptor` and `afterInterceptor` in your

File Location Differences

The location of certain files have changed or been replaced with other files in Grails 3.0. The following table lists the new locations:

Old Location	New Location
grails-app/conf/BuildConfig.groovy	build.gradle
grails-app/conf/Config.groovy	grails-app/conf/application.groovy
grails-app/conf/UrlMappings.groovy	grails-app/controllers/UrlMappings.g
grails-app/conf/BootStrap.groovy	grails-app/init/BootStrap.groovy
scripts	src/main/scripts
src/groovy	src/main/groovy
src/java	src/main/groovy
test/unit	src/test/groovy
test/integration	src/integration-test/groovy
web-app	src/main/webapp or src/main/resources/
*GrailsPlugin.groovy	src/main/groovy

src/main/resources/public is recommended as src/main/webapp only gets included in WA

For plugins the plugin descriptor (a Groovy file ending with "GrailsPlugin") which was previously located moved to the src/main/groovy directory under an appropriate package.

New Files Not Present in Grails 2.x

The reason it is best to create a new application and copy your original sources to it is because there are Grails 2.x by default. These include:

File	Description
build.gradle	The Gradle build descriptor located
gradle.properties	Properties file defining the Grails
grails-app/conf/logback.groovy	Logging previously defined in Co
grails-app/conf/application.yml	Configuration can now also be def
grails-app/init/PACKAGE_PATH/Application.groovy	The Application class used B

Files Not Present in Grails 3.x

Some files that were previously created by Grails 2.x are no longer created. These have either been removed. The following table lists files no longer in use:

File	Description
<code>application.properties</code>	The application name and version is now defined
<code>grails-app/conf/DataSource.groovy</code>	Merged together into <code>application.yml</code>
<code>lib</code>	Dependency resolution should be used to resolve
<code>web-app/WEB-INF/applicationContext.xml</code>	Removed, beans can be defined in <code>grails-app</code>
<code>src/templates/war/web.xml</code>	Grails 3.0 no longer requires <code>web.xml</code> . Customi
<code>web-app/WEB-INF/sitemesh.xml</code>	Removed, sitemesh filter no longer present.
<code>web-app/WEB-INF/tld</code>	Removed, can be restored in <code>src/main/web</code>

3.1 Upgrading from Grails 3.0

Generally to upgrade an application from Grails 3.0 you can simply modify the version of Grails in `gradle`

There are however some differences to Grails 3.0.x that are documented below.

GORM 5 Upgrade

Grails 3.1 ships with GORM 5, which is a near complete rewrite of GORM on top of Groovy traits and is a complete rewrite of GORM.

If you receive an error such as:

```
Caused by: java.lang.ClassNotFoundException: org.grails.datastore.gorm.GormEntity
... 8 more
```

You are using a plugin or class that was compiled with a previous version of GORM and these will need to be updated to be compatible.

Hibernate Plugin

For the GORM 5 release the hibernate plugin has been renamed to `hibernate4` (and there are hibernate5 and hibernate6 plugins). You should change your `build.gradle` to reflect that:

```
compile 'org.grails.plugins:hibernate4'
```

Static Resources Path

The default path for static resources resolved from `src/main/resources/public` has been changed instead of directly under the root of the application. For example a link in GSP pages such as:

```
${g.resource(dir:'files', file:'mydoc.pdf')}
```

Will produce a URI such as `/static/files/mydoc.pdf` instead of `/files/mydoc.pdf`. If you configure this in `application.yml`:

```
grails:
  resources:
    pattern: '/*'
```

Filters Plugin Removed

The Filters plugin was replaced by [Interceptors](#) in Grails 3.0.x, although the plugin was still present. In Grails 3.0.x you still wish to use the filters plugin you can add a dependency on the previous version provided by Grails.

```
compile 'org.grails:grails-plugin-filters:3.0.12'
```

Spring Transactional Proxies

Because the `grails.transactional.Transactional` transform already provides the ability to create transactional proxies, traditional support for transactional proxies has been disabled by default.

This means that if you have any services that use the `transactional` property and not the `Transactional` transform. For example the following service:

```
class FooService {
    static transactional = true
}
```

Becomes:

```
import grails.transaction.Transactional

@Transactional
class FooService {

}
```

In addition because in previous versions of a Grails transactional defaulted to true any services that were transactional were altered too.

If you wish to revert to the previous behavior then transactional proxies can be re-enabled with the following:

```
grails:
  spring:
    transactionManagement:
      proxies: true
```

JSON Converter changes

The default JSON converter no longer includes the class property by default. This can be re-enabled with the following:

```
grails:
  converters:
    domain:
      include:
        class: true
```

In addition the default JSON converter will no longer render the id property if it is null.

JSON Builder Groovy Alignment

The class `grails.web.JSONBuilder` has been deprecated and replaced with [groovy.json.StreamingBuilder](#) from Groovy. This avoids confusion with the differences between JSON builders and better aligns with Groovy's

This also means that any `render` blocks that rendered JSON will need to be updated to use the [groovy.json.StreamingBuilder](#). The following code:

```
render(contentType:"application/json") {  
    title = "The Stand"  
}
```

Should instead be written as:

```
render(contentType:"application/json") {  
    title "The Stand"  
}
```

If you are upgrading and prefer to continue to use the previous implementation then you can re-enable the configuration:

```
grails:  
  json:  
    legacy:  
      builder: true
```

JSON Views Replace JSON Converters

With the addition of JSON views the previous API for using JSON converters is largely discouraged in the future. It will be separated into an external plugin and JSON views phased in to replace it. The JSON converters provide a more fully featured, elegant API that is superior to writing JSON converters and/or marshallers.

Spring Boot 1.3 and Spring 4.2

Grails 3.1 ships with upgraded third party libraries that may require changes. See the [Spring Boot upgrade](#).

Unlike Spring Boot 1.2, Spring Boot 1.3 no longer uses the [Gradle Application Plugin](#) so if you relied on it, the plugin will need to be re-applied to your `build.gradle`.

Spring Boot 1.3 also uses Spring Security 4.x by default, so if your project depends on Spring Security 3.x you will need to update it.

```
compile 'org.springframework.security:spring-security-core:3.2.9.RELEASE'
compile 'org.springframework.security:spring-security-web:3.2.9.RELEASE'
```

Gradle run task no longer available by default

Because the Gradle run task for application startup was provided by the [Gradle Application Plugin](#) (see also [Gradle Application Plugin](#)), to use Gradle to start up your application, use the bootRun task instead, or re-apply the Application plugin in your build.gradle:

Note: If you don't have need of the Gradle Application plugin's features, but have custom Gradle tasks or I want to supply your own run task that depends on bootRun in your build.gradle:

```
task run(dependsOn: ['bootRun'])
```

Resource annotation defaults to JSON instead of XML

The [Resource](#) annotation applied to domain classes defaults to XML in Grails 3.0.x, but in Grails 3.1.x and later it defaults to JSON. If you use this annotation with the expectation of produces XML responses as the default you can modify the default by adding the following to your build.gradle:

```
import grails.rest.*

@Resource(formats=['xml', 'json'])
class MyDomainClass {}
```

This will restore the Grails 3.0.x behavior.

Geb and HTMLUnit 2.18

If you use Geb with HTMLUnit (something that is not recommended, as a more native driver such as Selenium is preferred), you should upgrade your dependencies in build.gradle:

```
testRuntime 'org.seleniumhq.selenium:selenium-htmlunit-driver:2.47.1'
testRuntime 'net.sourceforge.htmlunit:htmlunit:2.18'
```

Note that there are also some changes in behavior in HTMLUnit 2.18 that may cause issues in existing test

- Expressions that evaluate the title (Example `$('title')`) now return blank and should be replaced
- If you return plain text in a response without surrounding HTML tags, these are no longer regarded as required tags.

3.2 Upgrading from Grails 2.x

This guide takes you through the fundamentals of upgrading a Grails 2.x application or plugins to Grails 3.

3.2.1 Upgrading Plugins

To upgrade a Grails 2.x plugin to Grails 3.x you need to make a number of different changes. This document will guide you through the process of upgrading the Quartz plugin to Grails 3, each individual plugin may differ.

Step 1 - Create a new Grails 3 plugin

The first step is to create a new Grails 3 plugin using the command line:

```
$ grails create-plugin quartz
```

This will create a Grails 3 plugin in the `quartz` directory.

Step 2 - Copy sources from the original Grails 2 plugin

The next step is to copy the sources from the original Grails 2 plugin to the Grails 3 plugin:


```
# first the sources
cp -rf ../quartz-2.x/src/groovy/ src/main/groovy
cp -rf ../quartz-2.x/src/java/ src/main/groovy
cp -rf ../quartz-2.x/grails-app/ grails-app
cp -rf ../quartz-2.x/QuartzGrailsPlugin.groovy src/main/groovy/grails/plugins/qua

# then the tests
cp -rf ../quartz-2.x/test/unit/* src/test/groovy
mkdir -p src/integration-test/groovy
cp -rf ../quartz-2.x/test/integration/* src/integration-test/groovy

# then templates / other resources
cp -rf ../quartz-2.x/src/templates/ src/main/templates
```

Step 3 - Alter the plugin descriptor

You will need to add a package declaration to the plugin descriptor. In this case QuartzGrailsPlugin

```
// add package declaration
package grails.plugins.quartz
...
class QuartzGrailsPlugin {
}
...
```

In addition you should remove the version property from the descriptor as this is now defined in build

Step 4 - Update the Gradle build with required dependencies

The repositories and dependencies defined in grails-app/conf/BuildConfig.groovy of the or in build.gradle of the new Grails 3.x plugin:

```
compile("org.quartz-scheduler:quartz:2.2.1") {
    exclude group: 'slf4j-api', module: 'c3p0'
}
```

Step 5 - Modify Package Imports

In Grails 3.x all internal APIs can be found in the org.grails package and public fac org.codehaus.groovy.grails package no longer exists.

All package declaration in sources should be modified for the new location `org.codehaus.groovy.grails.commons.GrailsApplication` is now `grails.core.Gr`

Step 5 - Migrate Plugin Specific Config to application.yml

Some plugins define a default configuration file. For example the Quartz `grails-app/conf/DefaultQuartzConfig.groovy`. In Grails 3.x this default `grails-app/conf/application.yml` and it will automatically be loaded by Grails without requir

Step 6 - Update plugin exclusions

Old plugins may have a `pluginExcludes` property defined that lists the patterns for any files that shou normally used to exclude artifacts such as domain classes that are used in the plugin's integration tests. Yc application.

This property is no longer sufficient in Grails 3, and nor can you use source paths. Instead, you must speci classes. For example, imagine you have some test domain classes in the `grails-app/domain/plug` the `pluginExcludes` value to

```
def pluginExcludes = ["plugin/test/**"]
```


and then add this block to the build file:

```
jar {  
    exclude "plugin/test/**"  
}
```

The easiest way to ensure these patterns work effectively is to put all your non-packaged class into a separation between the main plugin classes and the rest.

Step 7 - Register ArtefactHandler Definitions

In Grails 3.x [ArtefactHandler](#) definitions written in Java need to b `src/main/resources/META-INF/grails.factories` since these need to be known at compile

 If the `ArtefactHandler` is written in Groovy this step can be skipped as Grails w `grails.factories` file during compilation.

The Quartz plugin requires the following definition to register the `ArtrefactHandler`:

```
grails.core.ArtefactHandler=grails.plugins.quartz.JobArtefactHandler
```

Step 8 - Migrate Code Generation Scripts

Many plugins previously defined command line scripts in Gant. In Grails 3.x command line scripts have been replaced by generation scripts and Gradle tasks.

If your script is doing simple code generation then for many cases a code generation script can replace an old script. The `create-job` script provided by the Quartz plugin in Grails 2.x was defined in `scripts/CreateJob.groovy`.

```
includeTargets << grailsScript("_GrailsCreateArtifacts")
target(createJob: "Creates a new Quartz scheduled job") {
    depends(checkVersion, parseArguments)
    def type = "Job"
    promptForName(type: type)
    for (name in argsMap.params) {
        name = purgeRedundantArtifactSuffix(name, type)
        createArtifact(name: name, suffix: type, type: type, path: "grails-app/jobs")
        createUnitTest(name: name, suffix: type)
    }
}
setDefaultTarget 'createJob'
```

A replacement Grails 3.x compatible script can be created using the `create-script` command:

```
$ grails create-script create-job
```

Which creates a new script called `src/main/scripts/create-job.groovy`. Using the new code

```

description("Creates a new Quartz scheduled job") {
    usage "grails create-job [JOB NAME]"
    argument name:'Job Name', description:"The name of the job"
}

model = model( args[0] )
render template:"Job.groovy",
        destination: file( "grails-app/jobs/$model.packagePath/${model.simpleName}
        model: model

```

Please refer to the documentation on [Creating Custom Scripts](#) for more information.

Migrating More Complex Scripts Using Gradle Tasks

Using the old Grails 2.x build system it was relatively common to spin up Grails inside the command line application within a code generation script created by the [create-script](#) command.

Instead a new mechanism specific to plugins exists via the [create-command](#) command. The [createApplicationCommand](#), for example the following command will execute a query:

```

import grails.dev.commands.*
import javax.sql.*
import groovy.sql.*
import org.springframework.beans.factory.annotation.*

class RunQueryCommand implements ApplicationCommand {

    @Autowired
    DataSource dataSource

    boolean handle(ExecutionContext ctx) {
        def sql = new Sql(dataSource)
        println sql.executeQuery("select * from foo")
        return true
    }
}

```

With this command in place once the plugin is installed into your local Maven cache you can add the plugin classpath of the application's build.gradle file:

```

buildscript {
    ...
    dependencies {
        classpath "org.grails.plugins:myplugin:0.1-SNAPSHOT"
    }
}
...
dependencies {
    runtime "org.grails.plugins:myplugin:0.1-SNAPSHOT"
}

```

Grails will automatically create a Gradle task called `runQuery` and a command named `run-query` s command:

```

$ grails run-query
$ gradle runQuery

```

Step 8 - Delete Files that were migrated or no longer used

You should now delete and cleanup the project of any files no longer required by Grails 3.x (`DataSource.groovy` etc.)

3.2.2 Upgrading Applications

Upgrading applications to Grails 3.x will require that you upgrade all plugins the application uses first, he section to first upgrade your plugins.

Step 1 - Create a New Application

Once the plugins are Grails 3.x compatible you can upgrade the application. To upgrade an application it i using the "web" profile:

```

$ grails create-app myapp
$ cd myapp

```

Step 2 - Migrate Sources

The next step is to copy the sources from the original Grails 2 application to the Grails 3 application:

```
# first the sources
cp -rf ../old_app/src/groovy/ src/main/groovy
cp -rf ../old_app/src/java/ src/main/groovy
cp -rf ../old_app/grails-app/ grails-app

# then the tests
cp -rf ../old_app/test/unit/ src/test/groovy
mkdir -p src/integration-test/groovy
cp -rf ../old_app/test/integration/ src/integration-test/groovy
```

Step 3 - Update the Gradle build with required dependencies

The repositories and dependencies defined in `grails-app/conf/BuildConfig.groovy` of the defined in `build.gradle` of the new Grails 3.x application.

Step 4 - Modify Package Imports

In Grails 3.x all internal APIs can be found in the `org.grails` package and public facade `org.codehaus.groovy.grails` package no longer exists.

All package declaration in sources should be modified for the new location `org.codehaus.groovy.grails.commons.GrailsApplication` is now `grails.core.Gr`

Step 5 - Migrate Configuration

The configuration of the application will need to be migrated, this can normally be done by simply renaming `grails-app/conf/application.groovy` and merging the content of `grails-app/conf/application.groovy`.

Note however that Log4j has been replaced by `grails-app/conf/logback.groovy` for `grails-app/conf/Config.groovy` should be migrated to [logback format](#).

Step 6 - Migrate web.xml Modifications to Spring

If you have a modified `web.xml` template then you will need to migrate this to Spring as Grails 3.x does not have one in `src/main/webapp/WEB-INF/web.xml`.

New servlets and filters can be registered as Spring beans or with [ServletRegistrationBean](#) and [FilterRegistrationBean](#).

Step 7 - Migrate Static Assets not handled by Asset Pipeline

If you have static assets in your `web-app` directory of your Grails 2.x application such as HTML files, assets such as static HTML pages and so on these should go in `src/main/resources/public`.

TLD descriptors and non public assets should go in `src/main/resources/WEB-INF`.

As noted earlier, `src/main/webapp` folder can also be used for this purpose but it is not recommended.

Step 8 - Migrate Tests

Once the package names are corrected unit tests will continue to run, however any tests that extend the need to be migrated to Spock or JUnit 4.

Integration tests will need to be annotated with the [Integration](#) annotation and should not extend GroovyTe

4 Configuration

It may seem odd that in a framework that embraces "convention-over-configuration" that we tackle this to actually develop an application without doing any configuration whatsoever, as the quick start demonstrates. You can override the conventions when you need to. Later sections of the user guide will mention what configuration options are available. The assumption is that you have at least read the first section of this chapter!

4.1 Basic Configuration

Configuration in Grails is generally split across 2 areas: build configuration and runtime configuration.

Build configuration is generally done via Gradle and the `build.gradle` file. Runtime configuration is done via the `grails-app/conf/application.yml` file.

If you prefer to use Grails 2.0-style Groovy configuration then you can create an additional `grails-config.groovy` file to specify configuration using Groovy's [ConfigSlurper](#) syntax.

For Groovy configuration the following variables are available to the configuration script:

Variable	Description
<code>userHome</code>	Location of the home directory for the account that is running the Grails application.
<code>grailsHome</code>	Location of the directory where you installed Grails. If the <code>GRAILS_HOME</code> environment variable is set, it overrides this value.
<code>appName</code>	The application name as it appears in <code>application.properties</code> .
<code>appVersion</code>	The application version as it appears in <code>application.properties</code> .

For example:

```
my.tmp.dir = "${userHome}/.grails/tmp"
```

If you want to read runtime configuration settings, i.e. those defined in `application.yml`, use the `grailsApplication.config` as a variable in controllers and tag libraries:

```
class MyController {
    def hello() {
        def recipient = grailsApplication.config.getProperty('foo.bar.hello')
        render "Hello ${recipient}"
    }
}
```


The `config` property of the `grailsApplication` object is an instance of the [Config](#) interface and provides the configuration of the application.

In particular, the `getProperty` method (seen above) is useful for efficiently retrieving configuration properties (the default type is `String`) and/or providing a default fallback value.

```
class MyController {
  def hello(Recipient recipient) {
    //Retrieve Integer property 'foo.bar.max.hellos', otherwise use value of
    def max = grailsApplication.config.getProperty('foo.bar.max.hellos', Integer)

    //Retrieve property 'foo.bar.greeting' without specifying type (default is String)
    def greeting = grailsApplication.config.getProperty('foo.bar.greeting', String)

    def message = (recipient.receivedHelloCount >= max) ?
      "Sorry, you've been greeted the max number of times" : "${greeting}, $recipient"
  }
  render message
}
```

Notice that the `Config` instance is a merged configuration based on Spring's [PropertySource](#) concept, merging system properties and the local application configuration into a single object.

`GrailsApplication` can be easily injected into services and other Grails artifacts:

```
import grails.core.*

class MyService {
  GrailsApplication grailsApplication

  String greeting() {
    def recipient = grailsApplication.config.getProperty('foo.bar.hello')
    return "Hello ${recipient}"
  }
}
```

Finally, you can also use Spring's [Value](#) annotation to inject configuration values:

```
import org.springframework.beans.factory.annotation.*

class MyController {
    @Value('${foo.bar.hello}')
    String recipient

    def hello() {
        render "Hello ${recipient}"
    }
}
```



In Groovy code you must use single quotes around the string for the value of the `Value` annotation. If you use double quotes, it will be interpreted as a GString not a Spring expression.

As you can see, when accessing configuration settings you use the same dot notation as when you define them.

4.1.1 Options for the yml format Config

`application.yml` was introduced in Grails 3.0 for an alternative format for the configuration tasks.

Using system properties / command line arguments

Suppose you are using the `JDBC_CONNECTION_STRING` command line argument and you want to access it in the following manner:

```
production:
  dataSource:
    url: '${JDBC_CONNECTION_STRING}'
```

Similarly system arguments can be accessed.

You will need to have this in `build.gradle` to modify the `bootRun` target if `grails run-app` is used.

```
run {
    systemProperties = System.properties
}
```

For testing the following will need to change the `test` task as follows

```
test {
    systemProperties = System.properties
}
```

4.1.2 Built in options

Grails has a set of core settings that are worth knowing about. Their defaults are suitable for most projects because you may need one or more of them later.

Runtime settings

On the runtime front, i.e. `grails-app/conf/application.yml`, there are quite a few more core settings.

- `grails.enable.native2ascii` - Set this to false if you do not require native2ascii conversion
- `grails.views.default.codec` - Sets the default encoding regime for GSPs - can be one of 'html' or 'urlencode' to reduce risk of XSS attacks, set this to 'html'.
- `grails.views.gsp.encoding` - The file encoding used for GSP source files (default: 'utf-8').
- `grails.mime.file.extensions` - Whether to use the file extension to dictate the mime type instead of using `grails.mime.types`.
- `grails.mime.types` - A map of supported mime types used for [Content Negotiation](#).
- `grails.serverURL` - A string specifying the server URL portion of absolute URLs. Example: `grails.serverURL="http://my.yourportal.com"`. See [createLink](#). Also used by redirects.
- `grails.views.gsp.sitemesh.preprocess` - Determines whether SiteMesh preprocesses the output of GSP rendering, but if you need SiteMesh to parse the generated HTML from a GSP view then disabling it will prevent you from understanding this advanced property: leave it set to true.
- `grails.reload.excludes` and `grails.reload.includes` - Configuring these directives allows you to reload specific source files. Each directive takes a list of strings that are the class names for project source files to be excluded from behavior or included accordingly when running the application in development with the `run-app` command. If the `grails.reload` directive is configured, then only the classes in that list will be reloaded.

4.1.3 Logging

By default logging in Grails 3.0 is handled by the [Logback logging framework](#) in the `grails-app/conf/logback.groovy` file.



If you prefer XML you can replace the `logback.groovy` file with a `logback.xml` file in the `grails-app/conf` directory.

For more information on configuring logging refer to the [Logback documentation](#) on the subject.

4.1.4 GORM

Grails provides the following GORM configuration options:

- `grails.gorm.failOnError` - If set to `true`, causes the `save()` method to throw a `grails.validation.ValidationException` if [validation](#) fails during a save. This option can be set to a list of Strings representing package names. If the value is a list of Strings then the `failOnError` behavior will only apply to the specified packages (including sub-packages). See the [save](#) method docs for more information.

For example, to enable `failOnError` for all domain classes:

```
grails:
  gorm:
    failOnError: true
```

and to enable `failOnError` for domain classes by package:

```
grails:
  gorm:
    failOnError:
      - com.companyname.somepackage
      - com.companyname.someotherpackage
```

- `grails.gorm.autoFlush` - If set to `true`, causes the [merge](#), [save](#) and [delete](#) methods to flush the database after each save using `save(flush: true)`.

4.2 The Application Class

Every new Grails application features an `Application` class within the `grails-app/init` directory.

The `Application` class subclasses the [GrailsAutoConfiguration](#) class and features a static `void init()` method that is used to initialize the application.

4.2.1 Executing the Application Class

There are several ways to execute the `Application` class, if you are using an IDE then you can simply run the application from your IDE which will start your Grails application.

This is also useful for debugging since you can debug directly from the IDE without having to connect to the application using the `--debug-jvm` command from the command line.

You can also package your application into a runnable WAR file, for example:

```
$ grails package
$ java -jar build/libs/myapp-0.1.war
```

This is useful if you plan to deploy your application using a container-less approach.

4.2.2 Customizing the Application Class

There are several ways in which you can customize the `Application` class.

Customizing Scanning

By default Grails will scan all known source directories for controllers, domain class etc., however if the scan you can do so by overriding the `packageNames()` method of the `Application` class:

```
class Application extends GrailsAutoConfiguration {
    @Override
    Collection<String> packageNames() {
        super.packageNames() + ['my.additional.package']
    }
    ...
}
```

Registering Additional Beans

The `Application` class can also be used as a source for Spring bean definitions, simply define a method and its object will become a Spring bean. The name of the method is used as the bean name:

```
class Application extends GrailsAutoConfiguration {
    @Bean
    MyType myBean() {
        return new MyType()
    }
    ...
}
```

4.2.3 The Application LifeCycle

The `Application` class also implements the [GrailsApplicationLifeCycle](#) interface which all plugins imp

This means that the Application class can be used to perform the same functions as a plugin. You can do `doWithSpring`, `doWithApplicationContext` and so on by overriding the appropriate method:

```
class Application extends GrailsAutoConfiguration {
    @Override
    Closure doWithSpring() {
        { ->
            mySpringBean(MyType)
        }
    }
    ...
}
```

4.3 Environments

Per Environment Configuration

Grails supports the concept of per environment configuration. The `application.yml` or `grails-app/conf` directory can use per-environment configuration using either YAML or the syntax. Consider the following default `application.yml` definition provided by Grails:

```
environments:
  development:
    dataSource:
      dbCreate: create-drop
      url: jdbc:h2:mem:devDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=
  test:
    dataSource:
      dbCreate: update
      url: jdbc:h2:mem:testDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=
  production:
    dataSource:
      dbCreate: update
      url: jdbc:h2:prodDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=FALSE
    properties:
      jmxEnabled: true
      initialSize: 5
  ...
```

The above can be expressed in Groovy syntax in `application.groovy` as follows:

```

dataSource {
  pooled = false
  driverClassName = "org.h2.Driver"
  username = "sa"
  password = ""
}
environments {
  development {
    dataSource {
      dbCreate = "create-drop"
      url = "jdbc:h2:mem:devDb"
    }
  }
  test {
    dataSource {
      dbCreate = "update"
      url = "jdbc:h2:mem:testDb"
    }
  }
  production {
    dataSource {
      dbCreate = "update"
      url = "jdbc:h2:prodDb"
    }
  }
}

```

Notice how the common configuration is provided at the top level and then an environments block provides the `dbCreate` and `url` properties of the `DataSource`.

Packaging and Running for Different Environments

Grails' [command line](#) has built in capabilities to execute any command within the context of a specific environment.

```
grails [environment] [command name]
```

In addition, there are 3 preset environments known to Grails: `dev`, `prod`, and `test` for development. To create a WAR for the `test` environment you would run:

```
grails test war
```

To target other environments you can pass a `grails.env` variable to any command:

```
grails -Dgrails.env=UAT run-app
```

Programmatic Environment Detection

Within your code, such as in a Gant script or a bootstrap class you can detect the environment using the [Environment](#) class.

```
import grails.util.Environment

...

switch (Environment.current) {
    case Environment.DEVELOPMENT:
        configureForDevelopment()
        break
    case Environment.PRODUCTION:
        configureForProduction()
        break
}
```

Per Environment Bootstrapping

It's often desirable to run code when your application starts up on a per-environment basis. The `grails-app/init/BootStrap.groovy` file's support for per-environment execution:

```
def init = { ServletContext ctx ->
    environments {
        production {
            ctx.setAttribute("env", "prod")
        }
        development {
            ctx.setAttribute("env", "dev")
        }
    }
    ctx.setAttribute("foo", "bar")
}
```

Generic Per Environment Execution

The previous `BootStrap` example uses the `grails.util.Environment` class internally to execute your own environment specific logic:


```
Environment.executeForCurrentEnvironment {
  production {
    // do something in production
  }
  development {
    // do something only in development
  }
}
```

4.4 The DataSource

Since Grails is built on Java technology setting up a data source requires some knowledge of JDBC (the Connectivity).

If you use a database other than H2 you need a JDBC driver. For example for MySQL you would need [Co](#)

Drivers typically come in the form of a JAR archive. It's best to use the dependency resolution to resolve t example you could add a dependency for the MySQL driver like this:

```
dependencies {
  runtime 'mysql:mysql-connector-java:5.1.29'
}
```

If you can't use dependency resolution then just put the JAR in your project's `lib` directory.

Once you have the JAR resolved you need to get familiar with how Grails manages its database configuration either `grails-app/conf/application.groovy` or `grails-app/conf/application.yml` which includes the following settings:

- `driverClassName` - The class name of the JDBC driver
- `username` - The username used to establish a JDBC connection
- `password` - The password used to establish a JDBC connection
- `url` - The JDBC URL of the database
- `dbCreate` - Whether to auto-generate the database from the domain model - one of 'create-drop', 'create', 'drop'
- `pooled` - Whether to use a pool of connections (defaults to true)
- `logSql` - Enable SQL logging to stdout
- `formatSql` - Format logged SQL
- `dialect` - A String or Class that represents the Hibernate dialect used to communicate with the database. See the [list of available dialects](#).
- `readOnly` - If true makes the DataSource read-only, which results in the connection pool being read-only.
- `transactional` - If false leaves the DataSource's transactionManager bean outside the chain of interceptors. This only applies to additional datasources.
- `persistenceInterceptor` - The default datasource is automatically wired up to the persistence interceptor. This can be disabled by setting this to true.
- `properties` - Extra properties to set on the DataSource bean. See the [Tomcat Pool documentation of the properties](#).
- `jmxExport` - If false, will disable registration of JMX MBeans for all DataSources. By default `jmxEnabled = true` in properties.

A typical configuration for MySQL in `application.groovy` may be something like:

```

dataSource {
    pooled = true
    dbCreate = "update"
    url = "jdbc:mysql://localhost:3306/my_database"
    driverClassName = "com.mysql.jdbc.Driver"
    dialect = org.hibernate.dialect.MySQL5InnoDBDialect
    username = "username"
    password = "password"
    properties {
        jmxEnabled = true
        initialSize = 5
        maxActive = 50
        minIdle = 5
        maxIdle = 25
        maxWait = 10000
        maxAge = 10 * 60000
        timeBetweenEvictionRunsMillis = 5000
        minEvictableIdleTimeMillis = 60000
        validationQuery = "SELECT 1"
        validationQueryTimeout = 3
        validationInterval = 15000
        testOnBorrow = true
        testWhileIdle = true
        testOnReturn = false
        jdbcInterceptors = "ConnectionState;StatementCache(max=200)"
        defaultTransactionIsolation = java.sql.Connection.TRANSACTION_READ_COMMITTED
    }
}

```



When configuring the DataSource do not include the type or the def keyword before any of Groovy will treat these as local variable definitions and they will not be processed. For example:

```

dataSource {
    boolean pooled = true // type declaration results in ignored local variable
    ...
}

```

Example of advanced configuration using extra properties:

```

dataSource {
    pooled = true
    dbCreate = "update"
    url = "jdbc:mysql://localhost:3306/my_database"
    driverClassName = "com.mysql.jdbc.Driver"
    dialect = org.hibernate.dialect.MySQL5InnoDBDialect
    username = "username"
    password = "password"
    properties {
        // Documentation for Tomcat JDBC Pool
        // http://tomcat.apache.org/tomcat-7.0-doc/jdbc-pool.html#Common_Attribute
        // https://tomcat.apache.org/tomcat-7.0-doc/api/org/apache/tomcat/jdbc/poo
        jmxEnabled = true
        initialSize = 5
        maxActive = 50
        minIdle = 5
        maxIdle = 25
        maxWait = 10000
        maxAge = 10 * 60000
        timeBetweenEvictionRunsMillis = 5000
        minEvictableIdleTimeMillis = 60000
        validationQuery = "SELECT 1"
        validationQueryTimeout = 3
        validationInterval = 15000
        testOnBorrow = true
        testWhileIdle = true
        testOnReturn = false
        ignoreExceptionOnPreLoad = true
        // http://tomcat.apache.org/tomcat-7.0-doc/jdbc-pool.html#JDBC_interceptor
        jdbcInterceptors = "ConnectionState;StatementCache(max=200)"
        defaultTransactionIsolation = java.sql.Connection.TRANSACTION_READ_COMMITT
        // controls for leaked connections
        abandonWhenPercentageFull = 100 // settings are active only when pool is f
        removeAbandonedTimeout = 120
        removeAbandoned = true
        // use JMX console to change this setting at runtime
        logAbandoned = false // causes stacktrace recording overhead, use only for
        // JDBC driver properties
        // Mysql as example
        dbProperties {
            // Mysql specific driver properties
            // http://dev.mysql.com/doc/connector-j/en/connector-j-reference-confi
            // let Tomcat JDBC Pool handle reconnecting
            autoReconnect=false
            // truncation behaviour
            jdbcCompliantTruncation=false
            // mysql 0-date conversion
            zeroDateTimeBehavior='convertToNull'
            // Tomcat JDBC Pool's StatementCache is used instead, so disable mysql
            cachePrepStmts=false
            cacheCallableStmts=false
            // Tomcat JDBC Pool's StatementFinalizer keeps track
            dontTrackOpenResources=true
            // performance optimization: reduce number of SQLExceptions thrown in
            holdResultsOpenOverStatementClose=true
            // enable MySQL query cache - using server prep stmts will disable que
            useServerPrepStmts=false
            // metadata caching
            cacheServerConfiguration=true
            cacheResultSetMetadata=true
            metadataCacheSize=100
            // timeouts for TCP/IP
            connectTimeout=15000
            socketTimeout=120000
            // timer tuning (disable)
            maintainTimeStats=false
            enableQueryTimeouts=false
            // misc tuning
            noDatetimeStringSync=true
        }
    }
}

```

More on dbCreate

Hibernate can automatically create the database tables required for your domain model. You have some control over this via the `dbCreate` property, which can take these values:

- **create** - Drops the existing schema and creates the schema on startup, dropping existing tables, indexes, and constraints.
- **create-drop** - Same as **create**, but also drops the tables when the application shuts down cleanly.
- **update** - Creates missing tables and indexes, and updates the current schema without dropping any tables. This is useful for many schema changes like column renames (you're left with the old column containing the existing data).
- **validate** - Makes no changes to your database. Compares the configuration with the existing database schema.
- any other value - does nothing

You can also remove the `dbCreate` setting completely, which is recommended once your schema is deployed in production. Database changes are then managed through a migration tool like [Liquibase](#) (the [Database Migration](#) plugin uses Liquibase and is tightly integrated with Grails).

4.4.1 DataSources and Environments

The previous example configuration assumes you want the same config for all environments: production, test, and development. Grails' `DataSource` definition is "environment aware", however, so you can do:

```
dataSource {
    pooled = true
    driverClassName = "com.mysql.jdbc.Driver"
    dialect = org.hibernate.dialect.MySQL5InnoDBDialect
    // other common settings here
}

environments {
    production {
        dataSource {
            url = "jdbc:mysql://liveip.com/liveDb"
            // other environment-specific settings here
        }
    }
}
```

4.4.2 Automatic Database Migration

The `dbCreate` property of the `DataSource` definition is important as it dictates what Grails should do when generating the database tables from [GORM](#) classes. The options are described in the [DataSource](#) section:

- create
- create-drop
- update
- validate
- no value

In [development](#) mode `dbCreate` is by default set to "create-drop", but at some point in development (need to stop dropping and re-creating the database every time you start up your server.

It's tempting to switch to `update` so you retain existing data and only update the schema when your code is conservative. It won't make any changes that could result in data loss, and doesn't detect renamed columns: it will also have the new one.

Grails supports migrations with Flyway or Liquibase using the [same mechanism provided by Spring Boot](#).

4.4.3 Transaction-aware DataSource Proxy

The actual `dataSource` bean is wrapped in a transaction-aware proxy so you will be given the connection `Hibernate Session` if one is active.

If this were not the case, then retrieving a connection from the `dataSource` would be a new connection that hasn't been committed yet (assuming you have a sensible transaction isolation setting, e.g. `READ_COMMITTED`).

The "real" unproxied `dataSource` is still available to you if you need access to it; its bean name is `dataSourceUnproxied`.

You can access this bean like any other Spring bean, i.e. using dependency injection:

```
class MyService {
  def dataSourceUnproxied
  ...
}
```

or by pulling it from the `ApplicationContext`:

```
def dataSourceUnproxied = ctx.dataSourceUnproxied
```

4.4.4 Database Console

The [H2 database console](#) is a convenient feature of H2 that provides a web-based interface to any database. It's especially useful when running against an in-memory database.

You can access the console by navigating to **http://localhost:8080/dbconsole** in a browser. `grails.dbconsole.urlRoot` attribute in `application.groovy` and defaults to `' /dbconsole'`

The console is enabled by default in development mode and can be disabled or enabled by the `grails.dbconsole.enabled` attribute in `application.groovy`. For example, you could enable

```
environments {
  production {
    grails.serverURL = "http://www.changeme.com"
    grails.dbconsole.enabled = true
    grails.dbconsole.urlRoot = '/admin/dbconsole'
  }
  development {
    grails.serverURL = "http://localhost:8080/${appName}"
  }
  test {
    grails.serverURL = "http://localhost:8080/${appName}"
  }
}
```



If you enable the console in production be sure to guard access to it using a trusted security framework.

Configuration

By default the console is configured for an H2 database which will work with the default settings if you have not changed the JDBC URL to `jdbc:h2:mem:devDB`. If you've configured an external database (e.g. PostgreSQL), you can use the Saved Settings dropdown to choose a settings template and fill in the url and username/password information.

4.4.5 Multiple Datasources

By default all domain classes share a single `DataSource` and a single database, but you have the option to configure multiple `DataSources`.

Configuring Additional DataSources

The default `DataSource` configuration in `grails-app/conf/application.yml` looks something like this:

```

---
dataSource:
  pooled: true
  jmxExport: true
  driverClassName: org.h2.Driver
  username: sa
  password:

environments:
  development:
    dataSource:
      dbCreate: create-drop
      url: jdbc:h2:mem:devDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=
  test:
    dataSource:
      dbCreate: update
      url: jdbc:h2:mem:testDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=
  production:
    dataSource:
      dbCreate: update
      url: jdbc:h2:prodDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=FALSE
      properties:
        jmxEnabled: true
        initialSize: 5

```

This configures a single `DataSource` with the Spring bean named `dataSource`. To configure extra `DataSource` beans (at the top level, in an environment block, or both, just like the standard `DataSource` definition) with a custom driver, you can use a second `DataSource`, using MySQL in the development environment and Oracle in production:


```

---
dataSources:
  dataSource:
    pooled: true
    jmxExport: true
    driverClassName: org.h2.Driver
    username: sa
    password:
  lookup:
    dialect: org.hibernate.dialect.MySQLInnoDBDialect
    driverClassName: com.mysql.jdbc.Driver
    username: lookup
    password: secret
    url: jdbc:mysql://localhost/lookup
    dbCreate: update

environments:
  development:
    dataSources:
      dataSource:
        dbCreate: create-drop
        url: jdbc:h2:mem:devDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=FALSE
  test:
    dataSources:
      dataSource:
        dbCreate: update
        url: jdbc:h2:mem:testDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=FALSE
  production:
    dataSources:
      dataSource:
        dbCreate: update
        url: jdbc:h2:prodDb;MVCC=TRUE;LOCK_TIMEOUT=10000;DB_CLOSE_ON_EXIT=FALSE
        properties:
          jmxEnabled: true
          initialSize: 5
      ...
    lookup:
      dialect: org.hibernate.dialect.Oracle10gDialect
      driverClassName: oracle.jdbc.driver.OracleDriver
      username: lookup
      password: secret
      url: jdbc:oracle:thin:@localhost:1521:lookup
      dbCreate: update

```

You can use the same or different databases as long as they're supported by Hibernate.

Configuring Domain Classes

If a domain class has no `DataSource` configuration, it defaults to the standard `'dataSource'`. See the [DomainClass](#) block to configure a non-default `DataSource`. For example, if you want to use the `ZipCode` domain to store zip codes, it looks like this:

```

class ZipCode {
    String code
    static mapping = {
        datasource 'lookup'
    }
}

```

A domain class can also use two or more DataSources. Use the datasources property with a list of:

```

class ZipCode {
    String code
    static mapping = {
        datasources(['lookup', 'auditing'])
    }
}

```

If a domain class uses the default DataSource and one or more others, use the special name 'DEFAULT':

```

class ZipCode {
    String code
    static mapping = {
        datasources(['lookup', 'DEFAULT'])
    }
}

```

If a domain class uses all configured DataSources use the special value 'ALL':

```
class ZipCode {
  String code
  static mapping = {
    datasource 'ALL'
  }
}
```

Namespaces and GORM Methods

If a domain class uses more than one `DataSource` then you can use the namespace implied by each particular `DataSource`. For example, consider this class which uses two `DataSources`:

```
class ZipCode {
  String code
  static mapping = {
    datasources(['lookup', 'auditing'])
  }
}
```

The first `DataSource` specified is the default when not using an explicit namespace, so in this case you can call methods on the 'auditing' `DataSource` with the `DataSource` name, for example:

```
def zipCode = ZipCode.auditing.get(42)
...
zipCode.auditing.save()
```

As you can see, you add the `DataSource` to the method call in both the static case and the instance case.

Hibernate Mapped Domain Classes

You can also partition annotated Java classes into separate `datasources`. Classes using the `grails-app/conf/hibernate.cfg.xml`. To specify that an annotated class uses a non-default `datasource` for that `datasource` with the file name prefixed with the `datasource` name.

For example if the `Book` class is in the default `datasource`, you would register that in `grails-app/conf`

```
<?xml version='1.0' encoding='UTF-8'?>
<!DOCTYPE hibernate-configuration PUBLIC
    "-//Hibernate/Hibernate Configuration DTD 3.0//EN"
    'http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd'>
<hibernate-configuration>
    <session-factory>
        <mapping class='org.example.Book' />
    </session-factory>
</hibernate-configuration>
```

and if the Library class is in the "ds2" datasource, you would register that in `grails-app/conf/ds`

```
<?xml version='1.0' encoding='UTF-8'?>
<!DOCTYPE hibernate-configuration PUBLIC
    "-//Hibernate/Hibernate Configuration DTD 3.0//EN"
    'http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd'>
<hibernate-configuration>
    <session-factory>
        <mapping class='org.example.Library' />
    </session-factory>
</hibernate-configuration>
```

The process is the same for classes mapped with hbm.xml files - just list them in the appropriate hibernate.

Services

Like Domain classes, by default Services use the default DataSource and PlatformTransactionManager. If you want to use a different DataSource, use the static datasource property, for example:

```
class DataService {
    static datasource = 'lookup'
    void someMethod(...) {
        ...
    }
}
```

A transactional service can only use a single DataSource, so be sure to only make changes for domain Service.

Note that the datasource specified in a service has no bearing on which datasources are used for domain classes themselves. It's used to declare which transaction manager to use.

What you'll see is that if you have a Foo domain class in `dataSource1` and a Bar domain class in `dataSource2`, a service method that saves a new Foo and a new Bar will only be transactional for Foo since they share the instance. If you want both to be transactional you'd need to use two services and XA datasources for two-p

Transactions across multiple datasources

Grails uses the Best Efforts 1PC pattern for handling transactions across multiple datasources.

The [Best Efforts 1PC pattern](#) is fairly general but can fail in some circumstances that the developer might not expect. It involves a synchronized single-phase commit of a number of resources. Because the [2PC](#) is not used, it can often be good enough if the participants are aware of the compromises.

The basic idea is to delay the commit of all resources as late as possible in a transaction so that the only thing that can fail (not a business-processing error). Systems that rely on Best Efforts 1PC reason that infrastructure failures are a small risk in return for higher throughput. If business-processing services are also designed to be idempotent, the

The BE1PC implementation was added in Grails 2.3.6. . Before this change additional datasources didn't participate in transactions in additional datasources were basically in auto commit mode. In some cases this might affect performance: on the start of each new transaction, the BE1PC transaction manager creates a new transaction for each additional datasource out of the BE1PC transaction manager by setting `transactional = false` for each additional datasource. Datasources with `readOnly = true` will also be left out of the chained transaction manager.

By default, the BE1PC implementation will add all beans implementing the Spring [PlatformTransactionManager](#) interface to the transaction manager. For example, a possible [JMSTransactionManager](#) bean in the Grails application's transaction manager's chain of transaction managers.

You can exclude transaction manager beans from the BE1PC implementation with the this configuration option:

```
grails.transaction.chainedTransactionManagerPostProcessor.blacklistPattern = '.*'
```

The exclude matching is done on the name of the transaction manager bean. The transaction managers of `dataSource1` or `readOnly = true` will be skipped and using this configuration option is not required in that case.

XA and Two-phase Commit

When the Best Efforts 1PC pattern isn't suitable for handling transactions across multiple transactional resources, there are several options available for adding XA/2PC support to Grails applications.

The [Spring transactions documentation](#) contains information about integrating the JTA/XA transaction manager. In that case, you can configure a bean with the name `transactionManager` manually in `resources.groovy`.

There is also [Atomikos plugin](#) available for XA support in Grails applications.

4.5 Versioning

Detecting Versions at Runtime

You can detect the application version using Grails' support for application metadata using the [GrailsApplication](#) interface. There is an implicit [grailsApplication](#) variable that can be used:

```
def version = grailsApplication.metadata.getApplicationVersion()
```

You can retrieve the version of Grails that is running with:

```
def grailsVersion = grailsApplication.metadata.getGrailsVersion()
```

or the `GrailsUtil` class:

```
import grails.util.GrailsUtil
...
def grailsVersion = GrailsUtil.grailsVersion
```

4.6 Project Documentation

Since Grails 1.2, the documentation engine that powers the creation of this documentation has been available.

The documentation engine uses a variation on the [Textile](#) syntax to automatically create project documentation.

Creating project documentation

To use the engine you need to follow a few conventions. First, you need to create a `src/docs/guide` directory. Then, you need to create the source docs themselves. Each chapter should have its own gdoc file and end up with something like:

```
+ src/docs/guide/introduction.gdoc
+ src/docs/guide/introduction/changes.gdoc
+ src/docs/guide/gettingStarted.gdoc
+ src/docs/guide/configuration.gdoc
+ src/docs/guide/configuration/build.gdoc
+ src/docs/guide/configuration/build/controllers.gdoc
```

Note that you can have all your gdoc files in the top-level directory if you want, but you can also put sub-section - as the above example shows.

Once you have your source files, you still need to tell the documentation engine what the structure of your `src/docs/guide/toc.yml` file that contains the structure and titles for each section. This file is structure of the user guide in tree form. For example, the above files could be represented as:

```
introduction:
  title: Introduction
  changes: Change Log
gettingStarted: Getting Started
configuration:
  title: Configuration
build:
  title: Build Config
  controllers: Specifying Controllers
```

The format is pretty straightforward. Any section that has sub-sections is represented with the corres followed by a colon. The next line should contain `title:` plus the title of the section as seen by the er after the title. Leaf nodes, i.e. those without any sub-sections, declare their title on the same line as the sect

That's it. You can easily add, remove, and move sections within the `toc.yml` to restructure the generated section names, i.e. the gdoc filenames, should be unique since they are used for creating internal links and the documentation engine will warn you of duplicate section names.

Creating reference items

Reference items appear in the Quick Reference section of the documentation. Each reference item belo located in the `src/docs/ref` directory. For example, suppose you have defined a new controller me Controllers category so you would create a gdoc text file at the following location:

```
+ src/docs/ref/Controllers/renderPDF.gdoc
```

Configuring Output Properties

There are various properties you can set within your `grails-app/conf/application.gr` documentation such as:

- **grails.doc.title** - The title of the documentation
- **grails.doc.subtitle** - The subtitle of the documentation
- **grails.doc.authors** - The authors of the documentation
- **grails.doc.license** - The license of the software
- **grails.doc.copyright** - The copyright message to display
- **grails.doc.footer** - The footer to use

Other properties such as the version are pulled from your project itself. If a title is not specified, the application name is used.

You can also customise the look of the documentation and provide images by setting a few other options:

- **grails.doc.css** - The location of a directory containing custom CSS files (type `java.io.File`)
- **grails.doc.js** - The location of a directory containing custom JavaScript files (type `java.io.File`)
- **grails.doc.style** - The location of a directory containing custom HTML templates for the guide (type `java.io.File`)
- **grails.doc.images** - The location of a directory containing image files for use in the style templates (type `java.io.File`)

One of the simplest ways to customise the look of the generated guide is to provide a value for `grails.doc.css`. Grails will automatically include this CSS file in the guide. You can also place a `grails.doc.js` file to override the styles for the PDF version of the guide.

Generating Documentation

Add the plugin in your `build.gradle`:

```
apply plugin: "org.grails.grails-doc"
```

Once you have created some documentation (refer to the syntax guide in the next chapter) you can generate the command:

```
gradle docs
```

This command will output an `docs/manual/index.html` which can be opened in a browser to view the documentation.

Documentation Syntax

As mentioned the syntax is largely similar to Textile or Confluence style wiki markup. The following secti

Basic Formatting

Monospace: `monospace`

```
@monospace@
```

Italic: *italic*

```
_italic_
```

Bold: **bold**

```
*bold*
```

Image:

```
!http://grails.org/images/new/grailslogo_topNav.png!
```

You can also link to internal images like so:

```
!someFolder/my_diagram.png!
```

This will link to an image stored locally within your project. There is currently no default location for `grails.doc.images` setting in `application.groovy` like so:

```
grails.doc.images = new File("src/docs/images")
```

In this example, you would put the `my_diagram.png` file in the directory `'src/docs/images/someFolder'`.

Linking

There are several ways to create links with the documentation generator. A basic external link can either use the following markup:

```
[Pivotal|http://www.pivotal.io/oss]
```

or

```
"Pivotal":http://www.pivotal.io/oss
```

For links to other sections inside the user guide you can use the `guide:` prefix with the name of the section:

```
[Intro|guide:introduction]
```

The section name comes from the corresponding `gdoc` filename. The documentation engine will warn you if the section name does not match.

To link to reference items you can use a special syntax:

```
[renderPDF|controllers]
```

In this case the category of the reference item is on the right hand side of the `|` and the name of the reference item is on the left hand side.

Finally, to link to external APIs you can use the `api :` prefix. For example:

```
[String|api:java.lang.String]
```

The documentation engine will automatically create the appropriate javadoc link in this case. To add additi in `grails-app/conf/application.groovy`. For example:

```
grails.doc.api.org.hibernate=  
    "http://docs.jboss.org/hibernate/stable/core/javadocs"
```

The above example configures classes within the `org.hibernate` package to link to the Hibernate web

Lists and Headings

Headings can be created by specifying the letter 'h' followed by a number and then a dot:

```
h3.<space>Heading3  
h4.<space>Heading4
```

Unordered lists are defined with the use of the `*` character:

```
* item 1  
** subitem 1  
** subitem 2  
* item 2
```

Numbered lists can be defined with the `#` character:

```
# item 1
```

Tables can be created using the `table` macro:

Name	Number
Albert	46
Wilma	1348
James	12

```
{table}
*Name* | *Number*
Albert | 46
Wilma | 1348
James | 12
{table}
```

Code and Notes

You can define code blocks with the `code` macro:

```
class Book {
    String title
}
```

```
{code}
class Book {
    String title
}
{code}
```


The example above provides syntax highlighting for Java and Groovy code, but you can also highlight XM

```
<hello>world</hello>
```

```
{code:xml}  
<hello>world</hello>  
{code}
```


There are also a couple of macros for displaying notes and warnings:

Note:

 This is a note!

```
{note}  
This is a note!  
{note}
```

Warning:

 This is a warning!

```
{warning}  
This is a warning!  
{warning}
```

4.7 Dependency Resolution

Dependency resolution is handled by the [Gradle build tool](#), all dependencies are defined in the `build.gradle` file. For more information, see the [Gradle documentation](#).

5 The Command Line

Grails 3.0's command line system differs greatly from previous versions of Grails and features APIs for in performing code generation.

When you type:

```
grails [command name]
```

Grails searches the [profile repository](#) based on the profile of the current application. If the profile is for a the web profile and the base profile which it inherits from.

Since command behavior is profile specific the web profile may provide different behavior for the run batch applications.

When you type the following command:

```
grails run-app
```

It results in a search for the following files:

- `PROJECT_HOME/scripts/RunApp.groovy`
- `PROFILE_REPOSITORY_PATH/profiles/web/commands/run-app.groovy` (if the web
- `PROFILE_REPOSITORY_PATH/profiles/web/commands/run-app.yml` (for YAML def

To get a list of all commands and some help about the available commands type:

```
grails help
```

which outputs usage instructions and the list of commands Grails is aware of:

```
grails [environment]* [target] [arguments]*'
```

```
| Examples:
```

```
$ grails dev run-app
```

```
$ grails create-app books
```

```
| Available Commands (type grails help 'command-name' for more info):
```

```
| Command Name Command Description
```

```
clean Cleans a Grails application's compiled so
```

```
compile Compiles a Grails application
```

```
...
```



Refer to the Command Line reference in the Quick Reference menu of the reference guide for individual commands

non-interactive mode

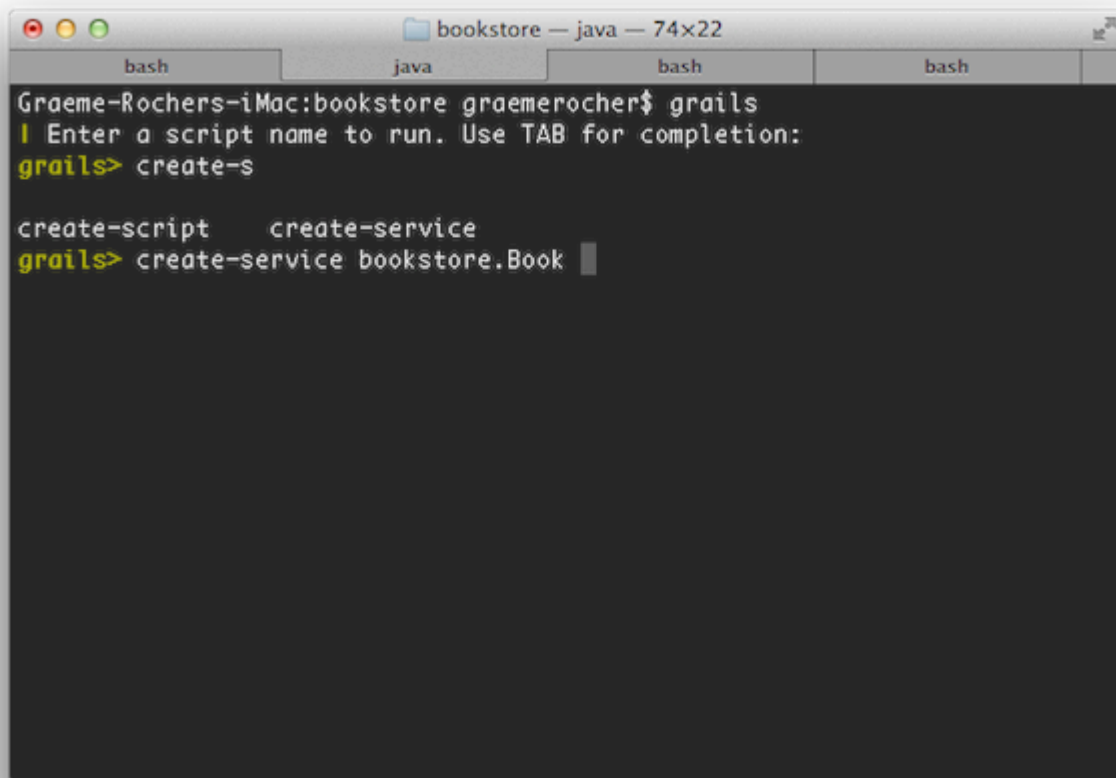
When you run a script manually and it prompts you for information, you can answer the questions and c script as part of an automated process, for example a continuous integration build server, there's no way --non-interactive switch to the script command to tell Grails to accept the default answer for a missing plugin.

For example:

```
grails war --non-interactive
```

5.1 Interactive Mode

Interactive mode is the a feature of the Grails command line which keeps the JVM running and allows f interactive mode type 'grails' at the command line and then use TAB completion to get a list of commands:

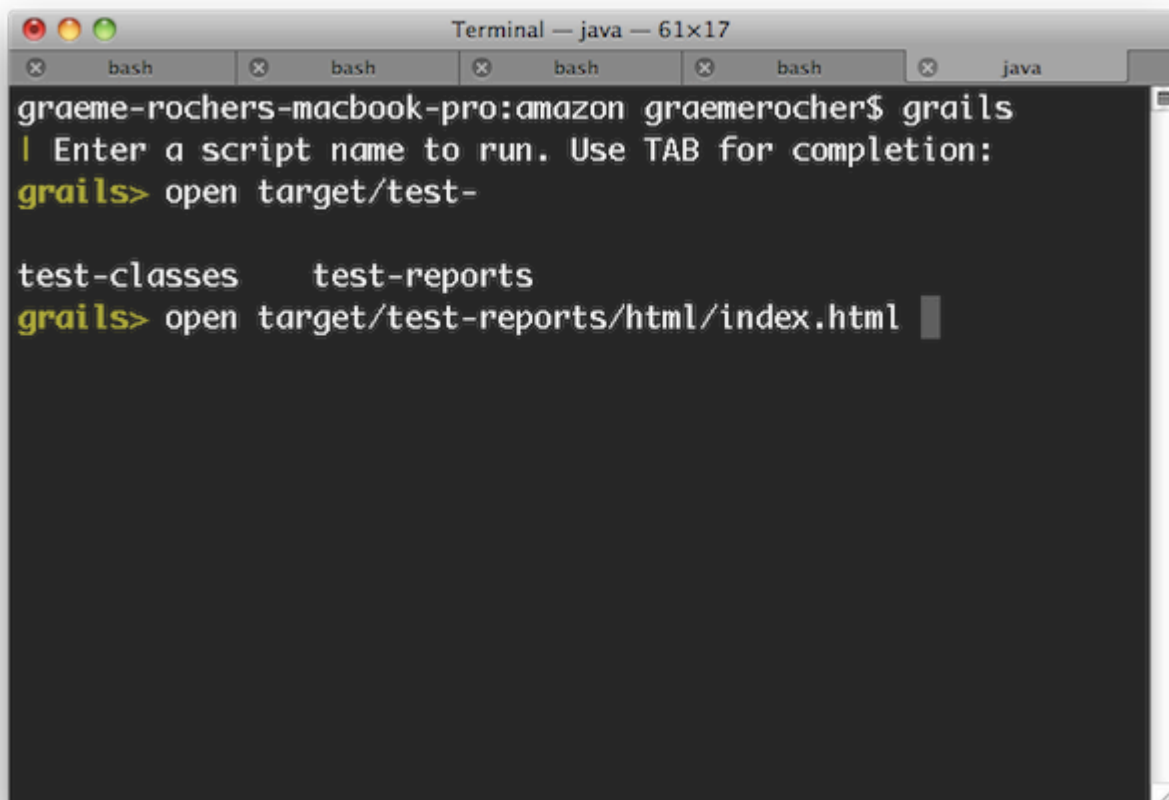


A terminal window titled "bookstore — java — 74x22" with tabs for "bash", "java", "bash", and "bash". The prompt is "Graeme-Rochers-iMac:bookstore graemerocher\$". The user enters "grails", which prompts "Enter a script name to run. Use TAB for completion:". The user then enters "grails> create-s", which shows suggestions "create-script" and "create-service". Finally, the user enters "grails> create-service bookstore.Book".

```
Graeme-Rochers-iMac:bookstore graemerocher$ grails
| Enter a script name to run. Use TAB for completion:
grails> create-s

create-script    create-service
grails> create-service bookstore.Book
```

If you need to open a file whilst within interactive mode you can use the open command which will TAB



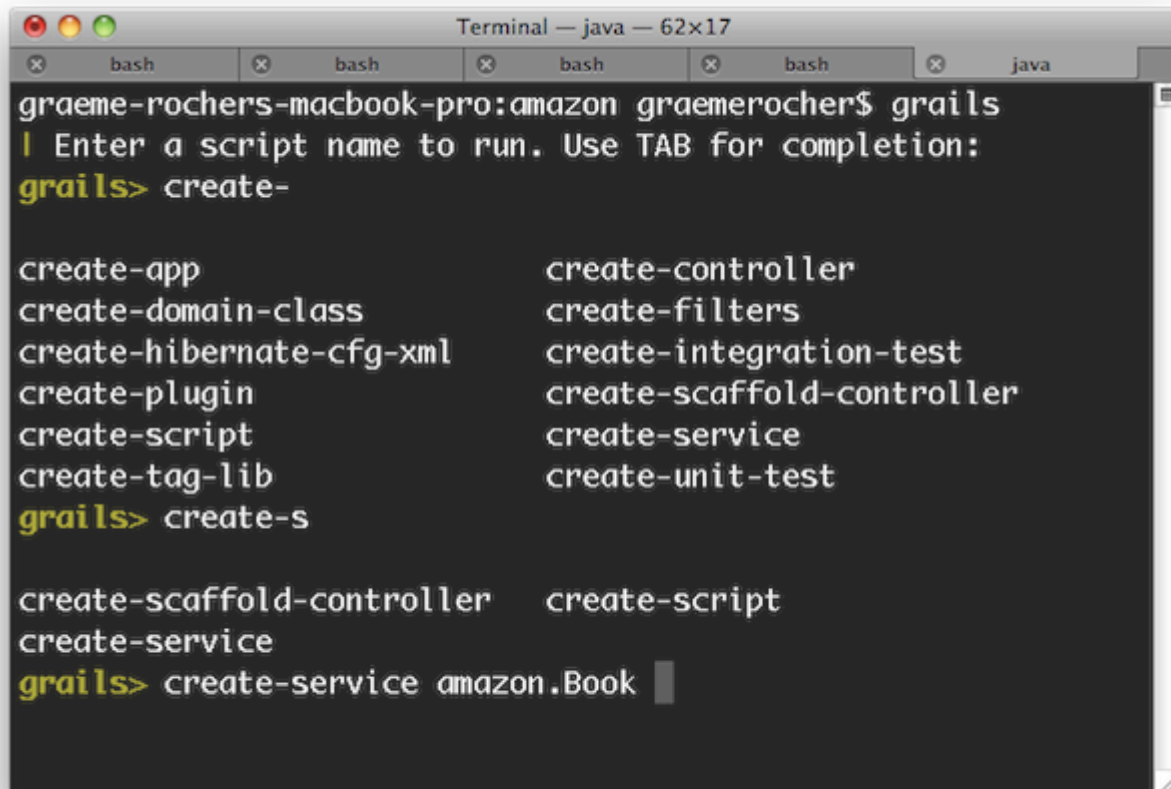
A terminal window titled "Terminal — java — 61x17" with tabs for "bash", "bash", "bash", "bash", and "java". The prompt is "graeme-rochers-macbook-pro:amazon graemerocher\$". The user enters "grails", which prompts "Enter a script name to run. Use TAB for completion:". The user then enters "grails> open target/test-", which shows suggestions "test-classes" and "test-reports". Finally, the user enters "grails> open target/test-reports/html/index.html".

```
graeme-rochers-macbook-pro:amazon graemerocher$ grails
| Enter a script name to run. Use TAB for completion:
grails> open target/test-

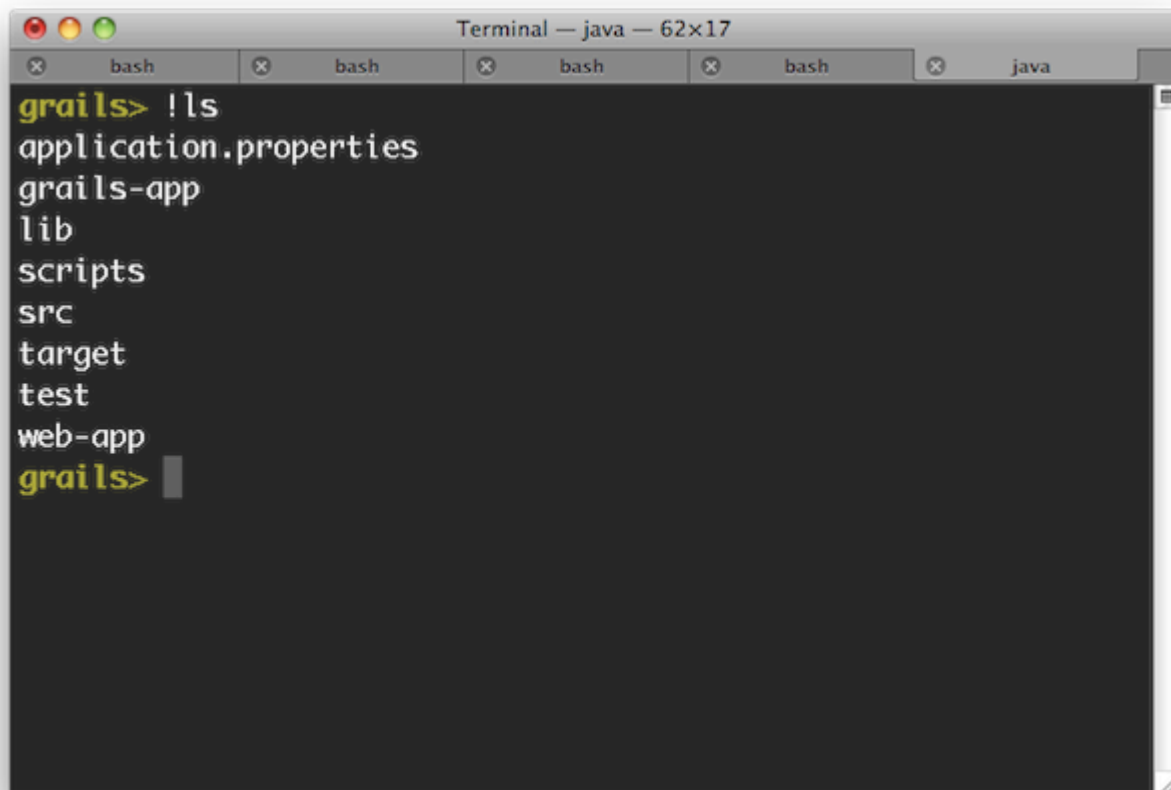
test-classes    test-reports
grails> open target/test-reports/html/index.html
```

Even better, the open command understands the logical aliases 'test-report' and 'dep-report', which will open the test report in a browser respectively. In other words, to open the test report in a browser simply execute `open test-report.` `test-report test/unit/MyTests.groovy` will open the HTML test report in your browser or a text editor.

TAB completion also works for class names after the `create-*` commands:

A screenshot of a macOS Terminal window titled "Terminal — java — 62x17". The window contains several tabs labeled "bash" and "java". The terminal shows the following sequence of commands and output:
1. `graeme-rochers-macbook-pro:amazon graemerocher$ grails`
2. Prompt: `| Enter a script name to run. Use TAB for completion:`
3. Command: `grails> create-`
4. Output (two columns):
 `create-app` `create-controller`
 `create-domain-class` `create-filters`
 `create-hibernate-cfg-xml` `create-integration-test`
 `create-plugin` `create-scaffold-controller`
 `create-script` `create-service`
 `create-tag-lib` `create-unit-test`
5. Command: `grails> create-s`
6. Output (two columns):
 `create-scaffold-controller` `create-script`
 `create-service`
7. Command: `grails> create-service amazon.Book` (with a cursor at the end)

If you need to run an external process whilst interactive mode is running you can do so by starting the com

A screenshot of a macOS Terminal window titled "Terminal — java — 62x17". The window has several tabs labeled "bash" and "java". The active tab is "bash". The prompt is "grails>". The user has entered "!ls" and the terminal shows the output: "application.properties", "grails-app", "lib", "scripts", "src", "target", "test", "web-app", and "grails>". The "grails>" prompt is highlighted in yellow.

```
grails> !ls
application.properties
grails-app
lib
scripts
src
target
test
web-app
grails>
```

Note that with ! (bang) commands, you get file path auto completion - ideal for external commands that etc.

To exit interactive mode enter the `exit` command. Note that if the Grails application has been run with interactive mode console exits because the JVM will be terminated. An exception to this would be if the means the application is running in a different JVM. In that case the application will be left running after want to exit interactive mode and stop an application that is running in forked mode, use the `quit` command application and then close interactive mode.

5.2 Creating Custom Scripts

You can create your own Command scripts by running the [create-script](#) command from the root of your project to create a script called `src/main/scripts/hello-world.groovy`:

```
grails create-script hello-world
```



In general Grails scripts should be used for scripting the Gradle based build system and not to load application classes and in fact should not since Gradle is required to construct the application.

See below for an example script that prints 'Hello World':

```
description "Example description", "grails hello-world"
println "Hello World"
```

The `description` method is used to define the output seen by `grails help` and to aid users of example of providing a description taken from the `generate-all` command:

```
description( "Generates a controller that performs CRUD operations and the associ
  usage "grails generate-all [DOMAIN CLASS]"
  flag name:'force', description:"Whether to overwrite existing files"
  argument name:'Domain Class', description:'The name of the domain class'
}
```

As you can see this description profiles usage instructions, a flag and an argument. This allows the comma

```
grails generate-all MyClass --force
```

5.3 Re-using Grails scripts

Grails ships with a lot of command line functionality out of the box that you may find useful in your own reference guide for info on all the commands).

Any script you create can invoke another Grails script simply by invoking a method:

```
testApp( )
```

The above will invoke the `test-app` command. You can also pass arguments using the method argument

```
testApp( '--debug-jvm' )
```

Invoking Gradle

Instead of invoking another Grails CLI command you can invoke Gradle directly using the `gradle` property.

```
gradle.compileGroovy()
```

Invoking Ant

You can also invoke Ant tasks from scripts which can help if you need to write code generation and automation.

```
ant.mkdir(dir: "path")
```

Template Generation

Plugins and applications that need to define template generation tasks can do so using scripts. An example is the `generate-all` and `generate-controllers` commands.

Every Grails script implements the [TemplateRenderer](#) interface which makes it trivial to render templates.

The following is an example of the [create-script](#) command written in Groovy:

```

description( "Creates a Grails script" ) {
    usage "grails create-script [SCRIPT NAME]"
    argument name:'Script Name', description:"The name of the script to create"
    flag name:'force', description:"Whether to overwrite existing files"
}

def scriptName = args[0]
def model = model(scriptName)
def overwrite = flag('force') ? true : false

render template: template('artifacts/Script.groovy'),
        destination: file("src/main/scripts/${model.lowerCaseName}.groovy"),
        model: model,
        overwrite: overwrite

```

5.4 Building with Gradle

Grails 3.1 uses the [Gradle Build System](#) for build related tasks such as compilation, running tests and is recommended to use Gradle 2.2 or above with Grails 3.1.

The build is defined by the `build.gradle` file which specifies the version of your project, the dependencies and how to find those dependencies (amongst other things).

When you invoke the `grails` command the version of Gradle that ships with Grails 3.1 (currently 2.9) is [Tooling API](#):

```

# Equivalent to 'gradle classes'
$ grails compile

```

You can invoke Gradle directly using the `gradle` command and use your own local version of Gradle, or you can work with Grails 3.0:

```

$ gradle assemble

```

5.4.1 Defining Dependencies with Gradle

Dependencies for your project are defined in the `dependencies` block. In general you can follow the [Gradle Dependency Management](#) to understand how to configure additional dependencies.

The default dependencies for the "web" profile can be seen below:

```

dependencies {
    compile 'org.springframework.boot:spring-boot-starter-logging'
    compile('org.springframework.boot:spring-boot-starter-actuator')
    compile 'org.springframework.boot:spring-boot-autoconfigure'
    compile 'org.springframework.boot:spring-boot-starter-tomcat'
    compile 'org.grails:grails-dependencies'
    compile 'org.grails:grails-web-boot'

    compile 'org.grails.plugins:hibernate'
    compile 'org.grails.plugins:cache'
    compile 'org.hibernate:hibernate-ehcache'

    runtime 'org.grails.plugins:asset-pipeline'
    runtime 'org.grails.plugins:scaffolding'

    testCompile 'org.grails:grails-plugin-testing'
    testCompile 'org.grails.plugins:geb'

    // Note: It is recommended to update to a more robust driver (Chrome, Firefox etc
    testRuntime 'org.seleniumhq.selenium:selenium-htmlunit-driver:2.44.0'

    console 'org.grails:grails-console'
}

```

Note that version numbers are not present in the majority of the dependencies. This is thanks to the Maven BOM that defines the default dependency versions for certain commonly used dependencies and pl

```

dependencyManagement {
    imports {
        mavenBom 'org.grails:grails-bom:' + grailsVersion
    }
    applyMavenExclusions false
}

```

5.4.2 Working with Gradle Tasks

As mentioned previously the `grails` command uses an embedded version of Gradle and certain Grails commands map onto their Gradle equivalents. The following table shows which Grails command invoke which

Grails Command	Gradle Task
clean	clean
compile	classes
package	assemble
run-app	bootRun
test-app	test
test-app --integration	integrationTest
war	assemble

You can invoke any of these Grails commands using their Gradle equivalents if you prefer:

```
$ gradle test
```

Note however that you will need to use a version of Gradle compatible with Grails 3.1 (Gradle 2.2 or above). If you are using a version of Gradle used by Grails you can do so with the `grails` command:

```
$ grails gradle compileGroovy
```

However, it is recommended you do this via interactive mode, as it greatly speeds up execution and provides auto-completion for tasks:

```
$ grails
| Enter a command name to run. Use TAB for completion:
grails> gradle compileGroovy
...
```

To find out what Gradle tasks are available without using interactive mode TAB completion you can use the `gradle tasks` command:


```
gradle tasks
```

5.4.3 Grails plugins for Gradle

When you create a new project with the [create-app](#) command, a default `build.gradle` is created. The with a set of Gradle plugins that allow Gradle to build the Grails project:

```
apply plugin:"war"  
apply plugin:"org.grails.grails-web"  
apply plugin:"org.grails.grails-gsp"  
apply plugin:"asset-pipeline"
```

The default plugins are as follows:

- `war` - The [WAR plugin](#) changes the packaging so that Gradle creates as WAR file from you applic wish to create only a runnable JAR file for standalone deployment.
- `asset-pipeline` - The [asset pipeline](#) plugin enables the compilation of static assets (JavaScript, C

Many of these are built in plugins provided by Gradle or third party plugins. The Gradle plugins that Grails

- `org.grails.grails-core` - The primary Grails plugin for Gradle, included by all other plugins
- `org.grails.grails-gsp` - The Grails GSP plugin adds precompilation of GSP files for product
- `org.grails.grails-doc` - A plugin for Gradle for using Grails 2.0's documentation engine.
- `org.grails.grails-plugin` - A plugin for Gradle for building Grails plugins.
- `org.grails.grails-plugin-publish` - A plugin for publishing Grails plugins to the central
- `org.grails.grails-profile` - A plugin for use when creating Grails [Profiles](#).
- `org.grails.grails-profile-publish` - A plugin for publishing Grails profiles to the centr
- `org.grails.grails-web` - The Grails Web gradle plugin configures Gradle to understand the C

6 Application Profiles

When you create a Grails application with the [create-app](#) command by default the "web" profile is used:

```
grails create-app myapp
```

You can specify a different profile with the profile argument:

```
grails create-app myapp --profile=rest-api
```

Profiles encapsulate the project commands, templates and plugins that are designed to work for a given p [on Github](#), whilst the profiles themselves are published as JAR files to the Grails central repository.

To find out what profiles are available use the [list-profiles](#) command:

```
$ grails list-profiles
```

For more information on a particular profile use the [profile-info](#) command:

```
$ grails profile-info rest-api
```

Profile Repositories

By default Grails will resolve profiles from the [Grails central repository](#). However, you can d `USER_HOME/grails/settings.groovy` file:

```

grails {
  profiles {
    repositories {
      myRepo {
        url = "http://foo.com/repo"
        snapshotsEnabled = true
      }
    }
  }
}

```



Note that Grails uses Aether to resolve profiles, as a Gradle instance is not yet available when is executed. This means that you can also define repositories and more advanced configur etc.) in your `USER_HOME/.m2/settings.xml` file if you wish.

6.1 Creating Profiles

The idea behind creating a new profile is that you can setup a default set of commands and plugins organisation.

To create a new profile you can use the [create-profile](#) command which will create a new empty profile that

```
$ grails create-profile mycompany
```

The above command will create a new profile in the "mycompany" directory where the command is ex directory you will get a set of commands for creating profiles:

```

$ cd mycompany
$ grails
| Enter a command name to run. Use TAB for completion:
grails>

create-command      create-creator-command      create-feature      create-genera
create-gradle-command  create-template

```

The commands are as follows:

- `create-command` - creates a new command that will be available from the Grails CLI when the pr
- `create-creator-command` - creates a command available to the CLI that renders a template (Ex
- `create-generator-command` - creates a command available to the CLI that renders a t
generate-controller)
- `create-feature` - creates a feature that can be used with this profile
- `create-gradle-command` - creates a CLI command that can invoke gradle
- `create-template` - creates a template that can be rendered by a command

To customize the dependencies for your profile you can specify additional dependencies in `profile.ym`

Below is an example `profile.yml` file:

```
features:
  defaults:
    - hibernate
    - asset-pipeline
build:
  plugins:
    - org.grails.grails-web
  excludes:
    - org.grails.grails-core
dependencies:
  compile:
    - "org.mycompany:myplugin:1.0.1"
```

With the above configuration in place you can publish the profile to your local repository with `gradle i`

```
$ gradle install
```

Your profile is now usable with the `create-app` command:

```
$ grails create-app myapp --profile mycompany
```

With the above command the application will be created with the "mycompany" profile which includes an and also includes the "hibernate" and "asset-pipeline" features (more on features later).

Note that if you customize the dependency coordinates of the profile (group, version etc.) then you may create an application:

```
$ grails create-app myapp --profile com.mycompany:mycompany:1.0.1
```

6.2 Profile Inheritance

One profile can extend one or many different parent profiles. To define profile inheritance you can modify the profile dependencies. For example typically you want to extend the base profile:

```
dependencies {
    runtime project(':base')
}
```

By inheriting from a parent profile you get the following benefits:

- When the [create-app](#) command is executed the parent profile's skeleton is copied first
- Dependencies and `build.gradle` is merged from the parent(s)
- The `application.yml` file is merged from the parent(s)
- CLI commands from the parent profile are inherited
- Features from the parent profile are inherited

To define the order of inheritance ensure that your dependencies are declared in the correct order. For example:

```
dependencies {
    runtime project(':plugin')
    runtime project(':web')
}
```

In the above snippet the skeleton from the "plugin" profile is copied first, followed by the "web" profile. CLI commands from the "plugin" profile, whilst if the dependency order was reversed the "plugin" profile would be inherited last.

6.3 Publishing Profiles

Publishing Profiles to the Grails Central Repository

Any profile created with the [create-profile](#) command already comes configured with a `grails.build.gradle`:

```
apply plugin: "org.grails.grails-profile-publish"
```

To publish a profile using this plugin to the Grails central repository first upload the source to [Github](#) (click [here](#) to register for an account on [Bintray](#) and configure your keys as follows in the profile's `build.gradle` file

```
grailsPublish {
    user = 'YOUR USERNAME'
    key = 'YOUR KEY'
    githubSlug = 'your-repo/your-profile'
    license = 'Apache-2.0'
}
```



The `githubSlug` argument should point to the path to your Github repository. For example at `https://github.com/foo/bar` then your `githubSlug` is `foo/bar`

With this in place you can run `gradle publishProfile` to publish your profile:

```
$ gradle publishProfile
```

The profile will be uploaded to Bintray. You can then go to the [Grails profiles repository](#) and request to "My Package" button on Bintray's interface (you must be logged in to see this).

Publishing Profiles to an Internal Repository

The aforementioned `grails-profile-publish` plugin configures [Gradle's Maven Publish plugin](#). you need to do is define the repository in `build.gradle`. For example:

```
publishing {
    repositories {
        maven {
            credentials {
                username "foo"
                password "bar"
            }
        }
    }
    url "http://foo.com/repo"
}
```

Once configured you can publish your plugin with `gradle publish`:

```
$ gradle publish
```

6.4 Understanding Profiles

A profile is a simple directory that contains a `profile.yml` file and directories containing the "comma profile. Example:

```
web
* commands
  * create-controller.yml
  * run-app.groovy
  ...
* features
  * asset-pipeline
  * skeleton
  * feature.yml
* skeleton
  * grails-app
  * controllers
  ...
  * build.gradle
* templates
  * artifacts
  * Controller.groovy
* profile.yml
```

The above example is a snippet of structure of the 'web' profile. The `profile.yml` file is used to des configured.

Understanding the profile.yml descriptor

The `profile.yml` can contain the following child elements.

1) repositories

A list of Maven repositories to include in the generated build. Example:

```
repositories:
  - "https://repo.grails.org/grails/core"
```

2) build.repositories

A list of Maven repositories to include in the buildscript section of the generated build. Example:

```
build:
  repositories:
    - "https://repo.grails.org/grails/core"
```

3) build.plugins

A list of Gradle plugins to configure in the generated build. Example:

```
build:
  plugins:
    - eclipse
    - idea
    - org.grails.grails-core
```

4) build.excludes

A list of Gradle plugins to exclude from being inherited from the parent profile:


```
build:
  excludes:
    - org.grails.grails-core
```

5) dependencies

A map of scopes and dependencies to configure. The `excludes` scope can be used to exclude from the project.

```
dependencies:
  excludes:
    - "org.grails:hibernate"
  build:
    - "org.grails:grails-gradle-plugin:$grailsVersion"
  compile:
    - "org.springframework.boot:spring-boot-starter-logging"
    - "org.springframework.boot:spring-boot-autoconfigure"
```

6) features.defaults

A default list of features to use if no explicit features are specified.

```
features:
  defaults:
    - hibernate
    - asset-pipeline
```

What happens when a profile is used?

When the `create-app` command runs it takes the skeleton of the parent profiles and copies the skeleton

The `build.gradle` file is generated as is result of obtaining all of the dependency information define required dependencies.

The command will also merge any `build.gradle` files defined within a profile and its parent profiles.

The `grails-app/conf/application.yml` file is also merged into a a single YAML file taking profiles.

6.5 Creating Profile Commands

A profile can define new commands that apply only to that profile using YAML or Groovy scripts. Below defined in YAML:

```
description:
  - Creates a controller
  - usage: 'create-controller [controller name]'
  - completer: org.grails.cli.interactive.completers.DomainClassCompleter
  - argument: "Controller Name"
  description: "The name of the controller"
steps:
  - command: render
    template: templates/artifacts/Controller.groovy
    destination: grails-app/controllers/artifact.package.path/artifact.nameController.groovy
  - command: render
    template: templates/testing/Controller.groovy
    destination: src/test/groovy/artifact.package.path/artifact.nameControllerSpec.groovy
  - command: mkdir
    location: grails-app/views/artifact.propertyName
```

Commands defined in YAML must define one or many steps. Each step is a command in itself. The available commands are:

- `render` - To render a template to a given destination (as seen in the previous example)
- `mkdir` - To make a directory specified by the `location` parameter
- `execute` - To execute a command specified by the `class` parameter. Must be a class that implements `Command`
- `gradle` - To execute one or many Gradle tasks specified by the `tasks` parameter.

For example to invoke a Gradle task, you can define the following YAML:

```
description: Creates a WAR file for deployment to a container (like Tomcat)
minArguments: 0
usage: |
  war
steps:
  - command: gradle
    tasks:
      - war
```

If you need more flexibility than what the declarative YAML approach provides you can create Groovy scripts from the [GroovyScriptCommand](#) class and hence has all of the methods of that class available to it.

The following is an example of the [create-script](#) command written in Groovy:

```

description( "Creates a Grails script" ) {
  usage "grails create-script [SCRIPT NAME]"
  argument name:'Script Name', description:"The name of the script to create"
  flag name:'force', description:"Whether to overwrite existing files"
}

def scriptName = args[0]
def model = model(scriptName)
def overwrite = flag('force') ? true : false

render template: template('artifacts/Script.groovy'),
  destination: file("src/main/scripts/${model.lowerCaseName}.groovy"),
  model: model,
  overwrite: overwrite

```

For more information on creating CLI commands see the section on [Creating custom scripts](#) in the Command Line Interface chapter.

6.6 Creating Profile Features

A Profile feature is a shareable set of templates and dependencies that may span multiple profiles. Typical features and child profiles that inherit from the parent and hence can use the features available from the parent.

To create a feature use the `create-feature` command from the root directory of your profile:

```
$ grails create-feature myfeature
```

This will create a `myfeature/feature.yml` file that looks like the following:

```

description: Description of the feature
# customize versions here
# dependencies:
#   compile:
#     - "org.grails.plugins:myplugin2:1.0"
#

```

As a more concrete example. The following is the `feature.yml` file from the "asset-pipeline" feature:

```
description: Adds Asset Pipeline to a Grails project
build:
  plugins:
    - asset-pipeline
dependencies:
  build:
    - 'com.bertram labs.plugins:asset-pipeline-gradle:2.5.0'
  runtime:
    - "org.grails.plugins:asset-pipeline"
```

The structure of a feature is as follows:

```
FEATURE_DIR
* feature.yml
* skeleton
  * grails-app
    * conf
      * application.yml
  * build.gradle
```

The contents of the skeleton get copied into the application tree, whilst the `application.yml` and `build.gradle` counterparts in the profile by used.

With the `feature.yml` you can define additional dependencies. This allows users to create applications

```
$ grails create-app myapp --profile myprofile --features myfeature,hibernate
```

The above example will create a new application using your new feature and the "hibernate" feature.

7 Object Relational Mapping (GORM)

Domain classes are core to any business application. They hold state about business processes and hope together through relationships; one-to-one, one-to-many, or many-to-many.

GORM is Grails' object relational mapping (ORM) implementation. Under the hood it uses Hibernate 3 solution) and thanks to the dynamic nature of Groovy with its static and dynamic typing, along with configuration involved in creating Grails domain classes.

You can also write Grails domain classes in Java. See the section on Hibernate Integration for how to write persistent methods. Below is a preview of GORM in action:

```
def book = Book.findByTitle("Groovy in Action")
book
  .addToAuthors(name:"Dierk Koenig")
  .addToAuthors(name:"Guillaume LaForge")
  .save()
```

7.1 Quick Start Guide

A domain class can be created with the [create-domain-class](#) command:

```
grails create-domain-class helloworld.Person
```



If no package is specified with the create-domain-class script, Grails automatically uses package name.

This will create a class at the location `grails-app/domain/helloworld/Person.groovy` such

```
package helloworld
class Person {
}
```



If you have the `dbCreate` property set to "update", "create" or "create-drop" on your application, Grails will automatically generate/modify the database tables for you.

You can customize the class by adding properties:

```
class Person {
    String name
    Integer age
    Date lastVisit
}
```

Once you have a domain class try and manipulate it with the [shell](#) or [console](#) by typing:

```
grails console
```

This loads an interactive GUI where you can run Groovy commands with access to the Spring Application Context.

7.1.1 Basic CRUD

Try performing some basic CRUD (Create/Read/Update/Delete) operations.

Create

To create a domain class use Map constructor to set its properties and call [save](#):

```
def p = new Person(name: "Fred", age: 40, lastVisit: new Date())
p.save()
```

The [save](#) method will persist your class to the database using the underlying Hibernate ORM layer.

Read

Grails transparently adds an implicit `id` property to your domain class which you can use for retrieval:

```
def p = Person.get(1)
assert 1 == p.id
```

This uses the [get](#) method that expects a database identifier to read the `Person` object back from the data state by using the [read](#) method:

```
def p = Person.read(1)
```

In this case the underlying Hibernate engine will not do any dirty checking and the object will not be persisted. After the `read` method then the object is placed back into a read-write state.

In addition, you can also load a proxy for an instance by using the [load](#) method:

```
def p = Person.load(1)
```

This incurs no database access until a method other than `getId()` is called. Hibernate then initializes the record if found for the specified id.

Update

To update an instance, change some properties and then call [save](#) again:

```
def p = Person.get(1)
p.name = "Bob"
p.save()
```

Delete

To delete an instance use the [delete](#) method:

```
def p = Person.get(1)
p.delete()
```

7.2 Domain Modelling in GORM

When building Grails applications you have to consider the problem domain you are trying to solve. For bookstore you would be thinking about books, authors, customers and publishers to name a few.

These are modeled in GORM as Groovy classes, so a Book class may have a title, a release date, an ISBN how to model the domain in GORM.

To create a domain class you run the [create-domain-class](#) command as follows:

```
grails create-domain-class org.bookstore.Book
```

The result will be a class at `grails-app/domain/org/bookstore/Book.groovy`:

```
package org.bookstore

class Book {
}
```

This class will map automatically to a table in the database called book (the same name as the class). The [Domain Specific Language](#)

Now that you have a domain class you can define its properties as Java types. For example:

```
package org.bookstore

class Book {
    String title
    Date releaseDate
    String ISBN
}
```


Each property is mapped to a column in the database, where the convention for column names is all low releaseDate maps onto a column release_date. The SQL types are auto-detected from the Java type, the [ORM DSL](#).

7.2.1 Association in GORM

Relationships define how domain classes interact with each other. Unless specified explicitly at both ends, they are defined.

7.2.1.1 Many-to-one and one-to-one

A many-to-one relationship is the simplest kind, and is defined with a property of the type of another domain class.

Example A

```
class Face {
    Nose nose
}
```

```
class Nose {
}
```

In this case we have a unidirectional many-to-one relationship from Face to Nose. To make this relationship bidirectional, we need to define a property of type Face in the Nose class (and see the section on controlling the ends of the association just below):

Example B

```
class Face {
    Nose nose
}
```

```
class Nose {  
    static belongsTo = [face:Face]  
}
```

In this case we use the belongsTo setting to say that Nose "belongs to" Face. The result of this is that to it and when we save or delete the Face instance, GORM will save or delete the Nose. In other words, associated Nose:

```
new Face(nose:new Nose()).save()
```

The example above will save both face and nose. Note that the inverse *is not* true and will result in an error

```
new Nose(face:new Face()).save() // will cause an error
```

Now if we delete the Face instance, the Nose will go too:

```
def f = Face.get(1)  
f.delete() // both Face and Nose deleted
```

To make the relationship a true one-to-one, use the hasOne property on the owning side, e.g. Face:

Example C

```
class Face {  
    static hasOne = [nose:Nose]  
}
```

```
class Nose {
    Face face
}
```

Note that using this property puts the foreign key on the inverse table to the example A, so in this case the inside a column called `face_id`. Also, `hasOne` only works with bidirectional relationships.

Finally, it's a good idea to add a unique constraint on one side of the one-to-one relationship:

```
class Face {
    static hasOne = [nose:Nose]
    static constraints = {
        nose unique: true
    }
}
```

```
class Nose {
    Face face
}
```

Controlling the ends of the association

Occasionally you may find yourself with domain classes that have multiple properties of the same type association property has the same type as the domain class it's in. Such situations can cause problems because association. Consider this simple class:

```
class Person {
    String name
    Person parent

    static belongsTo = [ supervisor: Person ]
    static constraints = { supervisor nullable: true }
}
```

As far as Grails is concerned, the `parent` and `supervisor` properties are two directions of the same property on a `Person` instance, Grails will automatically set the `supervisor` property on the other `Person` if you look at the class, what we in fact have are two unidirectional relationships.

To guide Grails to the correct mapping, you can tell it that a particular association is unidirectional through

```
class Person {
    String name
    Person parent

    static belongsTo = [ supervisor: Person ]
    static mappedBy = [ supervisor: "none", parent: "none" ]
    static constraints = { supervisor nullable: true }
}
```

You can also replace "none" with any property name of the target class. And of course this works for non-nullable ones. Nor is the `mappedBy` property limited to many-to-one and one-to-one associations: it also works for many-to-many as you'll see in the next section.



If you have a property called "none" on your domain class, this approach won't work currently as it is treated as the reverse direction of the association (or the "back reference"). Fortunately, "none" is not a valid class property name.


7.2.1.2 One-to-many

A one-to-many relationship is when one class, example `Author`, has many instances of another class, example `Book`, relationship with the `hasMany` setting:

```
class Author {
    static hasMany = [ books: Book ]
    String name
}
```


```
class Book {
    String title
}
```

In this case we have a unidirectional one-to-many. Grails will, by default, map this kind of relationship with

 The [ORM DSL](#) allows mapping unidirectional relationships using a foreign key association in

Grails will automatically inject a property of type `java.util.Set` into the domain class based on the over the collection:

```
def a = Author.get(1)
for (book in a.books) {
    println book.title
}
```

 The default fetch strategy used by Grails is "lazy", which means that the collection will be lazy. This can lead to the [n+1 problem](#) if you are not careful.

If you need "eager" fetching you can use the [ORM DSL](#) or specify eager fetching as part of a .

The default cascading behaviour is to cascade saves and updates, but not deletes unless a `belongsTo` is a

```
class Author {
    static hasMany = [books: Book]
    String name
}
```

```
class Book {
    static belongsTo = [author: Author]
    String title
}
```

If you have two properties of the same type on the many side of a one-to-many you have to use `mappedBy`:

```
class Airport {
    static hasMany = [flights: Flight]
    static mappedBy = [flights: "departureAirport"]
}
```

```
class Flight {
    Airport departureAirport
    Airport destinationAirport
}
```

This is also true if you have multiple collections that map to different properties on the many side:

```
class Airport {
    static hasMany = [outboundFlights: Flight, inboundFlights: Flight]
    static mappedBy = [outboundFlights: "departureAirport",
                      inboundFlights: "destinationAirport"]
}
```

```
class Flight {
    Airport departureAirport
    Airport destinationAirport
}
```

7.2.1.3 Many-to-many

Grails supports many-to-many relationships by defining a `hasMany` on both sides of the relationship and relationship:

```
class Book {
    static belongsTo = Author
    static hasMany = [authors:Author]
    String title
}
```

```
class Author {
    static hasMany = [books:Book]
    String name
}
```

Grails maps a many-to-many using a join table at the database level. The owning side of the relationship persisting the relationship and is the only side that can cascade saves across.

For example this will work and cascade saves:

```
new Author(name:"Stephen King")
    .addToBooks(new Book(title:"The Stand"))
    .addToBooks(new Book(title:"The Shining"))
    .save()
```

However this will only save the Book and not the authors!

```
new Book(name:"Groovy in Action")
    .addToAuthors(new Author(name:"Dierk Koenig"))
    .addToAuthors(new Author(name:"Guillaume Laforge"))
    .save()
```

This is the expected behaviour as, just like Hibernate, only one side of a many-to-many can take responsibility



Grails' [Scaffolding](#) feature **does not** currently support many-to-many relationship and hence you have to manually manage the relationship yourself

7.2.1.4 Basic Collection Types

As well as associations between different domain classes, GORM also supports mapping of basic collections. For example, if you create a `Person` class with a `nicknames` association that is a `Set` of `String` instances:

```
class Person {
    static hasMany = [nicknames: String]
}
```

GORM will map an association like the above using a join table. You can alter various aspects of how the association is mapped by using the `mapping` argument:

```
class Person {
    static hasMany = [nicknames: String]
    static mapping = {
        nicknames joinTable: [name: 'bunch_o_nicknames',
                               key: 'person_id',
                               column: 'nickname',
                               type: "text"]
    }
}
```

The example above will map to a table that looks like the following:

bunch_o_nicknames Table

person_id	nickname
1	Fred

7.2.2 Composition in GORM

As well as [association](#), Grails supports the notion of composition. In this case instead of mapping classes within the current table. For example:


```

class Person {
    Address homeAddress
    Address workAddress
    static embedded = ['homeAddress', 'workAddress']
}

class Address {
    String number
    String code
}

```

The resulting mapping would look like this:

Person Table

id	home_address _number	home_address _code	work_address _number	work_address _code
1	47	343432	67	43545



If you define the Address class in a separate Groovy file in the `grails-app/domain` directory, it will create an address table. If you don't want this to happen use Groovy's ability to define multiple classes in a single file. Define the Address class below the Person class in the `grails-app/domain/Person.groovy` file.

7.2.3 Inheritance in GORM

GORM supports inheritance both from abstract base classes and concrete persistent GORM entities. For example:

```

class Content {
    String author
}

```

```

class BlogEntry extends Content {
    URL url
}

```

```
class Book extends Content {
    String ISBN
}
```

```
class PodCast extends Content {
    byte[] audioStream
}
```

In the above example we have a parent `Content` class and then various child classes with more specific b

Considerations

At the database level Grails by default uses table-per-hierarchy mapping with a discriminator column call its subclasses (`BlogEntry`, `Book` etc.), share the **same** table.

Table-per-hierarchy mapping has a down side in that you **cannot** have non-nullable properties with table-per-subclass which can be enabled with the [ORM DSL](#)

However, excessive use of inheritance and table-per-subclass can result in poor query performance due advice is if you're going to use inheritance, don't abuse it and don't make your inheritance hierarchy too de

Polymorphic Queries

The upshot of inheritance is that you get the ability to polymorphically query. For example using the [list](#) all subclasses of `Content`:

```
def content = Content.list() // list all blog entries, books and podcasts
content = Content.findAllByAuthor('Joe Bloggs') // find all by author

def podCasts = PodCast.list() // list only podcasts
```

7.2.4 Sets, Lists and Maps

Sets of Objects

By default when you define a relationship with GORM it is a `java.util.Set` which is an unordered c words when you have:

```
class Author {
    static hasMany = [books: Book]
}
```

The books property that GORM injects is a `java.util.Set`. Sets guarantee uniqueness but not order. To get custom ordering you configure the Set as a `SortedSet`:

```
class Author {
    SortedSet books
    static hasMany = [books: Book]
}
```

In this case a `java.util.SortedSet` implementation is used which means you must implement `java`

```
class Book implements Comparable {
    String title
    Date releaseDate = new Date()
    int compareTo(obj) {
        releaseDate.compareTo(obj.releaseDate)
    }
}
```

The result of the above class is that the Book instances in the books collection of the Author class will be c

Lists of Objects

To keep objects in the order which they were added and to be able to reference them by index like an array

```
class Author {  
    List books  
    static hasMany = [books: Book]  
}
```

In this case when you add new elements to the books collection the order is retained in a sequential list and

```
author.books[0] // get the first book
```

The way this works at the database level is Hibernate creates a `books_idx` column where it saves the this order at the database level.

When using a `List`, elements must be added to the collection before being saved, otherwise you get a `org.hibernate.HibernateException: null index column for collection`:

```
// This won't work!  
def book = new Book(title: 'The Shining')  
book.save()  
author.addToBooks(book)  
  
// Do it this way instead.  
def book = new Book(title: 'Misery')  
author.addToBooks(book)  
author.save()
```

Bags of Objects

If ordering and uniqueness aren't a concern (or if you manage these explicitly) then you can use the `Hibernate`

The only change required for this is to define the collection type as a `Collection`:

```
class Author {
  Collection books
  static hasMany = [books: Book]
}
```

Since uniqueness and order aren't managed by Hibernate, adding to or removing from collections maps instances from the database, so this approach will perform better and require less memory than using a Set.

Maps of Objects

If you want a simple map of string/value pairs GORM can map this with the following:

```
class Author {
  Map books // map of ISBN:book names
}

def a = new Author()
a.books = [ "1590597583": "Grails Book" ]
a.save()
```

In this case the key and value of the map **MUST** be strings.

If you want a Map of objects then you can do this:

```
class Book {
  Map authors
  static hasMany = [authors: Author]
}

def a = new Author(name: "Stephen King")
def book = new Book()
book.authors = [stephen: a]
book.save()
```

The static hasMany property defines the type of the elements within the Map. The keys for the map **must**

A Note on Collection Types and Performance

The Java `Set` type doesn't allow duplicates. To ensure uniqueness when adding an entry to a `Set` association from the database. If you have a large numbers of entries in the association this can be costly in terms of performance.

The same behavior is required for `List` types, since Hibernate needs to load the entire association to maintain you anticipate a large numbers of records in the association that you make the association bidirectional so. For example consider the following code:

```
def book = new Book(title:"New Grails Book")
def author = Author.get(1)
book.author = author
book.save()
```

In this example the association link is being created by the child (`Book`) and hence it is not necessary to use fewer queries and more efficient code. Given an `Author` with a large number of associated `Book` instances you would see an impact on performance:

```
def book = new Book(title:"New Grails Book")
def author = Author.get(1)
author.addToBooks(book)
author.save()
```

You could also model the collection as a Hibernate `Bag` as described above.

7.3 Persistence Basics

A key thing to remember about Grails is that under the surface Grails is using [Hibernate](#) for persistence. [ActiveRecord](#) or [iBatis/MyBatis](#), Hibernate's "session" model may feel a little strange.

Grails automatically binds a Hibernate session to the currently executing request. This lets you use the [session](#) methods transparently.

Transactional Write-Behind

A useful feature of Hibernate over direct JDBC calls and even other frameworks is that when you call [save](#) or [flush](#) SQL operations **at that point**. Hibernate batches up SQL statements and executes them as late as possible before committing and closing the session. This is typically done for you automatically by Grails, which manages your Hibernate session.

Hibernate caches database updates where possible, only actually pushing the changes when it knows that the session is being flushed programmatically. One common case where Hibernate will flush cached updates is when performing a query that includes the results. But as long as you're doing non-conflicting saves, updates, and deletes, the write-behind can be a significant performance boost for applications that do a lot of database writes.

Note that flushing is not the same as committing a transaction. If your actions are performed in the context of a transaction, updates but the database will save the changes in its transaction queue and only finalize the updates when the transaction is committed.

7.3.1 Saving and Updating

An example of using the [save](#) method can be seen below:

```
def p = Person.get(1)
p.save()
```

This save will not be pushed to the database immediately - it will be pushed when the next flush occurs. You can control when those statements are executed or, in Hibernate terminology, when the session is "flushed".

save method:

```
def p = Person.get(1)
p.save(flush: true)
```

Note that in this case *all* pending SQL statements including previous saves, deletes, etc. will be synchronized to the database. Any exceptions, which is typically useful in highly concurrent scenarios involving [optimistic locking](#):

```
def p = Person.get(1)
try {
    p.save(flush: true)
}
catch (org.springframework.dao.DataIntegrityViolationException e) {
    // deal with exception
}
```

Another thing to bear in mind is that Grails [validates](#) a domain instance every time you save it. If that instance is not persisted to the database. By default, `save()` will simply return null in this case, but if you would pass the `failOnError` argument:

```
def p = Person.get(1)
try {
    p.save(failOnError: true)
}
catch (ValidationException e) {
    // deal with exception
}
```

You can even change the default behaviour with a setting in `application.groovy`, as described in [this article](#) when you are saving domain instances that have been bound with data provided by the user, the likelihood won't want those exceptions propagating to the end user.

You can find out more about the subtleties of saving data in [this article](#) - a must read!

7.3.2 Deleting Objects

An example of the [delete](#) method can be seen below:

```
def p = Person.get(1)
p.delete()
```

As with saves, Hibernate will use transactional write-behind to perform the delete; to perform the delete in

```
def p = Person.get(1)
p.delete(flush: true)
```

Using the `flush` argument lets you catch any errors that occur during a delete. A common error that may occur although this is normally down to a programming or schema error. The following `DataIntegrityViolationException` that is thrown when you violate the database constraints:


```

def p = Person.get(1)
try {
    p.delete(flush: true)
}
catch (org.springframework.dao.DataIntegrityViolationException e) {
    flash.message = "Could not delete person ${p.name}"
    redirect(action: "show", id: p.id)
}

```

Note that Grails does not supply a `deleteAll` method as deleting data is discouraged and can often be a bad idea. If you really need to batch delete data you can use the [executeUpdate](#) method to do batch DML statements

```

Customer.executeUpdate("delete Customer c where c.name = :oldName",
    [oldName: "Fred"])

```

7.3.3 Understanding Cascading Updates and Deletes

It is critical that you understand how cascading updates and deletes work when using GORM. The key parameter is `belongsTo` which controls which class "owns" a relationship.

Whether it is a one-to-one, one-to-many or many-to-many, defining `belongsTo` will result in updates cascading to the other side of the relationship, and for many-to-many and one-to-many relationships deletes will also cascade.

If you *do not* define `belongsTo` then no cascades will happen and you will have to manually save each object. (In the case of one-to-one relationships, which case saves will cascade automatically if a new instance is in a `hasMany` collection).

Here is an example:

```

class Airport {
    String name
    static hasMany = [flights: Flight]
}

```

```
class Flight {  
  String number  
  static belongsTo = [airport: Airport]  
}
```

If I now create an Airport and add some Flights to it I can save the Airport and have the updates whole object graph:

```
new Airport(name: "Gatwick")  
  .addToFlights(new Flight(number: "BA3430"))  
  .addToFlights(new Flight(number: "EZ0938"))  
  .save()
```

Conversely if I later delete the Airport all Flights associated with it will also be deleted:

```
def airport = Airport.findByName("Gatwick")  
airport.delete()
```

However, if I were to remove belongsTo then the above cascading deletion code **would not work** summaries below that describe the default behaviour of GORM with regards to specific associations. Articles to get a deeper understanding of relationships and cascading.

Bidirectional one-to-many with belongsTo

```
class A { static hasMany = [bees: B] }
```

```
class B { static belongsTo = [a: A] }
```

In the case of a bidirectional one-to-many where the many side defines a `belongsTo` then the cascade "NONE" for the many side.

Unidirectional one-to-many

```
class A { static hasMany = [bees: B] }
```

```
class B { }
```

In the case of a unidirectional one-to-many where the many side defines no `belongsTo` then the cascade str

Bidirectional one-to-many, no `belongsTo`

```
class A { static hasMany = [bees: B] }
```

```
class B { A a }
```

In the case of a bidirectional one-to-many where the many side does not define a `belongsTo` then the c the one side and "NONE" for the many side.

Unidirectional one-to-one with `belongsTo`

```
class A { }
```

```
class B { static belongsTo = [a: A] }
```

In the case of a unidirectional one-to-one association that defines a `belongsTo` then the cascade strategy (A->B) and "NONE" from the side that defines the `belongsTo` (B->A)

Note that if you need further control over cascading behaviour, you can use the [ORM DSL](#).

7.3.4 Eager and Lazy Fetching

Associations in GORM are by default lazy. This is best explained by example:

```
class Airport {  
    String name  
    static hasMany = [flights: Flight]  
}
```

```
class Flight {  
    String number  
    Location destination  
    static belongsTo = [airport: Airport]  
}
```

```
class Location {  
    String city  
    String country  
}
```

Given the above domain classes and the following code:

```
def airport = Airport.findByName("Gatwick")
for (flight in airport.flights) {
  println flight.destination.city
}
```

GORM will execute a single SQL query to fetch the `Airport` instance, another to get its `flights`, and `flights` association to get the current flight's destination. In other words you get N+1 queries (if you exc

Configuring Eager Fetching

An alternative approach that avoids the N+1 queries is to use eager fetching, which can be specified as foll

```
class Airport {
  String name
  static hasMany = [flights: Flight]
  static mapping = {
    flights lazy: false
  }
}
```

In this case the `flights` association will be loaded at the same time as its `Airport` instance, although collection. You can also use `fetch: 'join'` instead of `lazy: false`, in which case GORM will or their flights. This works well for single-ended associations, but you need to be careful with one-to-many; the moment you add a limit to the number of results you want. At that point, you will likely end up with fe for this is quite technical but ultimately the problem arises from GORM using a left outer join.

So, the recommendation is currently to use `fetch: 'join'` for single-ended associations and `lazy:`

Be careful how and where you use eager loading because you could load your entire database into mem find more information on the mapping options in the [section on the ORM DSL](#).

Using Batch Fetching

Although eager fetching is appropriate for some cases, it is not always desirable. If you made everything database into memory resulting in performance and memory problems. An alternative to eager fetchir Hibernate to lazily fetch results in "batches". For example:

```
class Airport {
    String name
    static hasMany = [flights: Flight]
    static mapping = {
        flights batchSize: 10
    }
}
```

In this case, due to the `batchSize` argument, when you iterate over the `flights` association, Hibernate if you had an `Airport` that had 30 flights, if you didn't configure batch fetching you would get 1 query fetch each flight. With batch fetching you get 1 query to fetch the `Airport` and 3 queries to fetch each 1 fetching is an optimization of the lazy fetching strategy. Batch fetching can also be configured at the class

```
class Flight {
    ...
    static mapping = {
        batchSize 10
    }
}
```

Check out [part 3](#) of the GORM Gotchas series for more in-depth coverage of this tricky topic.

7.3.5 Pessimistic and Optimistic Locking

Optimistic Locking

By default GORM classes are configured for optimistic locking. Optimistic locking is a feature of Hibernate special `version` column in the database that is incremented after each update.

The `version` column gets read into a `version` property that contains the current versioned state of pers

```
def airport = Airport.get(10)
println airport.version
```

When you perform updates Hibernate will automatically check the `version` property against the `version` throw a [StaleObjectException](#). This will roll back the transaction if one is active.

This is useful as it allows a certain level of atomicity without resorting to pessimistic locking that has an in you have to deal with this exception if you have highly concurrent writes. This requires flushing the session

```
def airport = Airport.get(10)
try {
  airport.name = "Heathrow"
  airport.save(flush: true)
}
catch (org.springframework.dao.OptimisticLockingFailureException e) {
  // deal with exception
}
```

The way you deal with the exception depends on the application. You could attempt a programmatic merge to resolve the conflict.

Alternatively, if it becomes a problem you can resort to pessimistic locking.



The version will only be updated after flushing the session.

Pessimistic Locking

Pessimistic locking is equivalent to doing a SQL "SELECT * FOR UPDATE" statement and locking a record. Other read operations will be blocking until the lock is released.

In Grails pessimistic locking is performed on an existing instance with the [lock](#) method:

```
def airport = Airport.get(10)
airport.lock() // lock for update
airport.name = "Heathrow"
airport.save()
```

Grails will automatically deal with releasing the lock for you once the transaction has been committed. However, "upgrading" from a regular SELECT to a SELECT..FOR UPDATE and another thread could still have updated the record and the call to `lock()`.

To get around this problem you can use the static [lock](#) method that takes an id just like [get](#):

```
def airport = Airport.lock(10) // lock for update
airport.name = "Heathrow"
airport.save()
```

In this case only `SELECT..FOR UPDATE` is issued.

As well as the [lock](#) method you can also obtain a pessimistic locking using queries. For example using a dy

```
def airport = Airport.findByName("Heathrow", [lock: true])
```

Or using criteria:

```
def airport = Airport.createCriteria().get {  
    eq('name', 'Heathrow')  
    lock true  
}
```

7.3.6 Modification Checking

Once you have loaded and possibly modified a persistent domain class instance, it isn't straightforward to the instance using [get](#) Hibernate will return the current modified instance from its Session cache. Reload which could cause problems if your data isn't ready to be flushed yet. So GORM provides some method caches when it loads the instance (which it uses for dirty checking).

isDirty

You can use the [isDirty](#) method to check if any field has been modified:

```
def airport = Airport.get(10)  
assert !airport.isDirty()  
  
airport.properties = params  
if (airport.isDirty()) {  
    // do something based on changed state  
}
```



`isDirty()` does not currently check collection associations, but it does check all other associations.

You can also check if individual fields have been modified:


```
def airport = Airport.get(10)
assert !airport.isDirty()

airport.properties = params
if (airport.isDirty('name')) {
    // do something based on changed name
}
```

getDirtyPropertyNames

You can use the [getDirtyPropertyNames](#) method to retrieve the names of modified fields; this may be emp

```
def airport = Airport.get(10)
assert !airport.isDirty()

airport.properties = params
def modifiedFieldNames = airport.getDirtyPropertyNames()
for (fieldName in modifiedFieldNames) {
    // do something based on changed value
}
```

getPersistentValue

You can use the [getPersistentValue](#) method to retrieve the value of a modified field:

```
def airport = Airport.get(10)
assert !airport.isDirty()

airport.properties = params
def modifiedFieldNames = airport.getDirtyPropertyNames()
for (fieldName in modifiedFieldNames) {
    def currentValue = airport."$fieldName"
    def originalValue = airport.getPersistentValue(fieldName)
    if (currentValue != originalValue) {
        // do something based on changed value
    }
}
```

7.4 Querying with GORM

GORM supports a number of powerful ways to query from dynamic finders, to criteria to Hibernate's objects. Depending on the complexity of the query you have the following options in order of flexibility and power:

- Dynamic Finders
- Where Queries
- Criteria Queries
- Hibernate Query Language (HQL)

In addition, Groovy's ability to manipulate collections with [GPath](#) and methods like `sort`, `findAll` and so on, is a powerful combination.

However, let's start with the basics.

Listing instances

Use the [list](#) method to obtain all instances of a given class:

```
def books = Book.list()
```

The [list](#) method supports arguments to perform pagination:

```
def books = Book.list(offset:10, max:20)
```

as well as sorting:

```
def books = Book.list(sort:"title", order:"asc")
```

Here, the `sort` argument is the name of the domain class property that you wish to sort on, and the `order` argument is `asc` for ascending or `desc` for descending.

Retrieval by Database Identifier

The second basic form of retrieval is by database identifier using the [get](#) method:

```
def book = Book.get(23)
```

You can also obtain a list of instances for a set of identifiers using [getAll](#):

```
def books = Book.getAll(23, 93, 81)
```

7.4.1 Dynamic Finders

GORM supports the concept of **dynamic finders**. A dynamic finder looks like a static method invocation, in any form at the code level.

Instead, a method is auto-magically generated using code synthesis at runtime, based on the properties of a

```
class Book {  
    String title  
    Date releaseDate  
    Author author  
}
```

```
class Author {  
    String name  
}
```

The Book class has properties such as title, releaseDate and author. These can be used by the "method expressions":

```
def book = Book.findByTitle("The Stand")
book = Book.findByTitleLike("Harry Pot%")
book = Book.findByReleaseDateBetween(firstDate, secondDate)
book = Book.findByReleaseDateGreaterThan(someDate)
book = Book.findByTitleLikeOrReleaseDateLessThan("%Something%", someDate)
```

Method Expressions

A method expression in GORM is made up of the prefix such as [findBy](#) followed by an expression that can be evaluated to a boolean value. The expression is:

```
Book.findBy([Property][Comparator][Boolean Operator])?[Property][Comparator]
```

The tokens marked with a '?' are optional. Each comparator changes the nature of the query. For example:

```
def book = Book.findByTitle("The Stand")
book = Book.findByTitleLike("Harry Pot%")
```

In the above example the first query is equivalent to equality whilst the latter, due to the `Like` comparator, is equivalent to a partial match. The possible comparators include:

- `InList` - In the list of given values
- `LessThan` - less than a given value
- `LessThanEquals` - less than or equal a give value
- `GreaterThan` - greater than a given value
- `GreaterThanEquals` - greater than or equal a given value
- `Like` - Equivalent to a SQL like expression
- `ILike` - Similar to a `Like`, except case insensitive
- `NotEqual` - Negates equality
- `InRange` - Between the `from` and `to` values of a Groovy Range
- `Rlike` - Performs a Regexp LIKE in MySQL or Oracle otherwise falls back to `Like`
- `Between` - Between two values (requires two arguments)
- `IsNull` - Not a null value (doesn't take an argument)
- `NotNull` - Is a null value (doesn't take an argument)

Notice that the last three require different numbers of method arguments compared to the rest, as demonstr

```
def now = new Date()
def lastWeek = now - 7
def book = Book.findByReleaseDateBetween(lastWeek, now)

books = Book.findAllByReleaseDateIsNull()
books = Book.findAllByReleaseDateIsNotNull()
```

Boolean logic (AND/OR)

Method expressions can also use a boolean operator to combine two or more criteria:

```
def books = Book.findAllByTitleLikeAndReleaseDateGreaterThan(
    "%Java%", new Date() - 30)
```

In this case we're using `And` in the middle of the query to make sure both conditions are satisfied, but you

```
def books = Book.findAllByTitleLikeOrReleaseDateGreaterThan(
    "%Java%", new Date() - 30)
```

You can combine as many criteria as you like, but they must all be combined with `And` or `Or`. If you n criteria creates a very long method name, just convert the query to a [Criteria](#) or [HQL](#) query.

Querying Associations

Associations can also be used within queries:

```
def author = Author.findByName("Stephen King")
def books = author ? Book.findAllByAuthor(author) : []
```

In this case if the `Author` instance is not null we use it in a query to obtain all the `Book` instances for the

Pagination and Sorting

The same pagination and sorting parameters available on the [list](#) method can also be used with dynamic fir

```
def books = Book.findAllByTitleLike("Harry Pot%",
    [max: 3, offset: 2, sort: "title", order: "desc"])
```

7.4.2 Where Queries

The `where` method, introduced in Grails 2.0, builds on the support for [Detached Criteria](#) by providing an common queries. The `where` method is more flexible than dynamic finders, less verbose than criteria a queries.

Basic Querying

The `where` method accepts a closure that looks very similar to Groovy's regular collection methods. T regular Groovy syntax, for example:

```
def query = Person.where {
    firstName == "Bart"
}
Person bart = query.find()
```

The returned object is a `DetachedCriteria` instance, which means it is not associated with any particular instance. You can use the `where` method to define common queries at the class level:

```
class Person {
    static simpsons = where {
        lastName == "Simpson"
    }
    ...
}
...
Person.simpsons.each {
    println it.firstname
}
```

Query execution is lazy and only happens upon usage of the [DetachedCriteria](#) instance. If you want to explore variations of the `findAll` and `find` methods to accomplish this:

```
def results = Person.findAll {
    lastName == "Simpson"
}
def results = Person.findAll(sort:"firstName") {
    lastName == "Simpson"
}
Person p = Person.find { firstName == "Bart" }
```

Each Groovy operator maps onto a regular criteria method. The following table provides a map of Groovy

Operator	Criteria Method	Description
==	eq	Equal to
!=	ne	Not equal to
>	gt	Greater than
<	lt	Less than
>=	ge	Greater than or equal to
<=	le	Less than or equal to
in	inList	Contained within the given list
==~	like	Like a given string
=~	ilike	Case insensitive like

It is possible use regular Groovy comparison operators and logic to formulate complex queries:

```
def query = Person.where {
    (lastName != "Simpson" && firstName != "Fred") || (firstName == "Bart" && age
}
def results = query.list(sort:"firstName")
```

The Groovy regex matching operators map onto like and ilike queries unless the expression on the right they map onto an rlike query:

```
def query = Person.where {
    firstName ==~ ~/B.+ /
}
```



Note that rlike queries are only supported if the underlying database supports regular expressions.

A between criteria query can be done by combining the in keyword with a range:


```
def query = Person.where {  
  age in 18..65  
}
```

Finally, you can do `isNull` and `isNotNull` style queries by using `null` with regular comparison operators.

```
def query = Person.where {  
  middleName == null  
}
```

Query Composition

Since the return value of the `where` method is a [DetachedCriteria](#) instance you can compose new queries from existing ones.

```
def query = Person.where {  
  lastName == "Simpson"  
}  
def bartQuery = query.where {  
  firstName == "Bart"  
}  
Person p = bartQuery.find()
```

Note that you cannot pass a closure defined as a variable into the `where` method unless it has been explicitly named. In other words the following will produce an error:

```
def callable = {  
  lastName == "Simpson"  
}  
def query = Person.where(callable)
```

The above must be written as follows:

```
import grails.gorm.DetachedCriteria

def callable = {
    lastName == "Simpson"
} as DetachedCriteria<Person>
def query = Person.where(callable)
```

As you can see the closure definition is cast (using the Groovy as keyword) to a [DetachedCriteria](#) instance

Conjunction, Disjunction and Negation

As mentioned previously you can combine regular Groovy logical operators (`||` and `&&`) to form conjunc

```
def query = Person.where {
    (lastName != "Simpson" && firstName != "Fred") || (firstName == "Bart" && age
```

You can also negate a logical comparison using `!`:

```
def query = Person.where {
    firstName == "Fred" && !(lastName == 'Simpson')
}
```

Property Comparison Queries

If you use a property name on both the left hand and right side of a comparison expression then tl automatically used:

```
def query = Person.where {
    firstName == lastName
}
```

The following table described how each comparison operator maps onto each criteria property comparison

Operator	Criteria Method	Description
==	eqProperty	Equal to
!=	neProperty	Not equal to
>	gtProperty	Greater than
<	ltProperty	Less than
>=	geProperty	Greater than or equal to
<=	leProperty	Less than or equal to

Querying Associations

Associations can be queried by using the dot operator to specify the property name of the association to be

```
def query = Pet.where {
  owner.firstName == "Joe" || owner.firstName == "Fred"
}
```

You can group multiple criterion inside a closure method call where the name of the method matches the a

```
def query = Person.where {
  pets { name == "Jack" || name == "Joe" }
}
```

This technique can be combined with other top-level criteria:

```
def query = Person.where {
  pets { name == "Jack" } || firstName == "Ed"
}
```

For collection associations it is possible to apply queries to the size of the collection:

```
def query = Person.where {
    pets.size() == 2
}
```

The following table shows which operator maps onto which criteria method for each size() comparison:

Operator	Criteria Method	Description
==	sizeEq	The collection size is equal to
!=	sizeNe	The collection size is not equal to
>	sizeGt	The collection size is greater than
<	sizeLt	The collection size is less than
>=	sizeGe	The collection size is greater than or equal to
<=	sizeLe	The collection size is less than or equal to

Subqueries

It is possible to execute subqueries within where queries. For example to find all the people older than the :

```
final query = Person.where {
    age > avg(age)
}
```

The following table lists the possible subqueries:

Method	Description
avg	The average of all values
sum	The sum of all values
max	The maximum value
min	The minimum value
count	The count of all values
property	Retrieves a property of the resulting entities

You can apply additional criteria to any subquery by using the `of` method and passing in a closure contain

```
def query = Person.where {  
  age > avg(age).of { lastName == "Simpson" } && firstName == "Homer"  
}
```

Since the property subquery returns multiple results, the criterion used compares all results. For example, younger than people with the surname "Simpson":

```
Person.where {  
  age < property(age).of { lastName == "Simpson" }  
}
```

More Advanced Subqueries in GORM

The support for subqueries has been extended. You can now use in with nested subqueries

```
def results = Person.where {  
  firstName in where { age < 18 }.firstName  
}.list()
```

Criteria and where queries can be seamlessly mixed:

```
def results = Person.withCriteria {  
  notIn "firstName", Person.where { age < 18 }.firstName  
}
```

Subqueries can be used with projections:

```
def results = Person.where {  
  age > where { age > 18 }.avg('age')  
}
```

Correlated queries that span two domain classes can be used:

```
def employees = Employee.where {  
  region.continent in ['APAC', "EMEA"]  
}.id()  
def results = Sale.where {  
  employee in employees && total > 100000  
}.employee.list()
```

And support for aliases (cross query references) using simple variable declarations has been added to wher

```
def query = Employee.where {  
  def em1 = Employee  
  exists Sale.where {  
    def s1 = Sale  
    def em2 = employee  
    return em2.id == em1.id  
  }.id()  
}  
def results = query.list()
```

Other Functions

There are several functions available to you within the context of a query. These are summarized in the tab

Method	Description
second	The second of a date property
minute	The minute of a date property
hour	The hour of a date property
day	The day of the month of a date property
month	The month of a date property
year	The year of a date property
lower	Converts a string property to upper case
upper	Converts a string property to lower case
length	The length of a string property
trim	Trims a string property



Currently functions can only be applied to properties or associations of domain classes. You cannot apply a function on a result of a subquery.

For example the following query can be used to find all pet's born in 2011:

```
def query = Pet.where {
  year(birthDate) == 2011
}
```

You can also apply functions to associations:

```
def query = Person.where {
  year(pets.birthDate) == 2009
}
```

Batch Updates and Deletes

Since each `where` method call returns a [DetachedCriteria](#) instance, you can use `where` queries to execute batch updates and deletes. For example, the following query will update all people with the surname "Simpson" to have the surname "Simpsonson".

```
def query = Person.where {
    lastName == 'Simpson'
}
int total = query.updateAll(lastName: "Bloggs")
```



Note that one limitation with regards to batch operations is that join queries (queries that join tables) are not allowed.

To batch delete records you can use the `deleteAll` method:

```
def query = Person.where {
    lastName == 'Simpson'
}
int total = query.deleteAll()
```

7.4.3 Criteria

Criteria is an advanced way to query that uses a Groovy builder to construct potentially complex queries by building query strings using a `StringBuffer`.

Criteria can be used either with the [createCriteria](#) or [withCriteria](#) methods. The builder uses Hibernate's `Criteria` class and its static methods found in the [Restrictions](#) class of the Hibernate Criteria API. For example:

```
def c = Account.createCriteria()
def results = c {
    between("balance", 500, 1000)
    eq("branch", "London")
    or {
        like("holderFirstName", "Fred%")
        like("holderFirstName", "Barney%")
    }
    maxResults(10)
    order("holderLastName", "desc")
}
```

This criteria will select up to 10 Account objects in a List matching the following criteria:

- balance is between 500 and 1000
- branch is 'London'
- holderFirstName starts with 'Fred' or 'Barney'

The results will be sorted in descending order by holderLastName.

If no records are found with the above criteria, an empty List is returned.

Conjunctions and Disjunctions

As demonstrated in the previous example you can group criteria in a logical OR using an `or { }` block:

```
or {  
  between("balance", 500, 1000)  
  eq("branch", "London")  
}
```

This also works with logical AND:

```
and {  
  between("balance", 500, 1000)  
  eq("branch", "London")  
}
```

And you can also negate using logical NOT:

```
not {  
  between("balance", 500, 1000)  
  eq("branch", "London")  
}
```

All top level conditions are implied to be AND'd together.

Querying Associations

Associations can be queried by having a node that matches the property name. For example say the Account

```
class Account {
  ...
  static hasMany = [transactions: Transaction]
  ...
}
```

We can query this association by using the property name `transactions` as a builder node:

```
def c = Account.createCriteria()
def now = new Date()
def results = c.list {
  transactions {
    between('date', now - 10, now)
  }
}
```

The above code will find all the `Account` instances that have performed `transactions` within the 10 queries within logical blocks:

```
def c = Account.createCriteria()
def now = new Date()
def results = c.list {
  or {
    between('created', now - 10, now)
    transactions {
      between('date', now - 10, now)
    }
  }
}
```

Here we find all accounts that have either performed transactions in the last 10 days OR have been recently

Querying with Projections

Projections may be used to customise the results. Define a "projections" node within the criteria builder methods within the projections node to the methods found in the Hibernate [Projections](#) class:

```

def c = Account.createCriteria()
def numberOfBranches = c.get {
    projections {
        countDistinct('branch')
    }
}

```

When multiple fields are specified in the projection, a List of values will be returned. A single value will b

SQL Projections

The criteria DSL provides access to Hibernate's SQL projection API.

```

// Box is a domain class...
class Box {
    int width
    int height
}

```

```

// Use SQL projections to retrieve the perimeter and area of all of the Box insta
def c = Box.createCriteria()

def results = c.list {
    projections {
        sqlProjection '(2 * (width + height)) as perimeter, (width * height) as are
[INTEGER, INTEGER]
    }
}

```

The first argument to the `sqlProjection` method is the SQL which defines the projections. The second argument is the list of column aliases corresponding to the projected values expressed in the SQL. The third argument is a list of Java types which correspond to the projected values expressed in the SQL. The API supports all `org.hibernate.type.StandardBasicTypes`. `INTEGER`, `LONG`, `FLOAT` etc. are provided by the DSL which correspond to `org.hibernate.type.StandardBasicTypes`.

Consider that the following table represents the data in the BOX table.

width	height
2	7
2	8
2	9
4	9

The query above would return results like this:

```
[[18, 14], [20, 16], [22, 18], [26, 36]]
```

Each of the inner lists contains the 2 projected values for each Box, perimeter and area.



Note that if there are other references in scope wherever your criteria query is expressed that any of the type constants described above, the code in your criteria will refer to those references provided by the DSL. In the unlikely event of that happening you can disambiguate the correct qualified Hibernate type. For example `StandardBasicTypes.INTEGER` instead of `INTEGER`.

If only 1 value is being projected, the alias and the type do not need to be included in a list.

```
def results = c.list {
  projections {
    sqlProjection 'sum(width * height) as totalArea', 'totalArea', INTEGER
  }
}
```

That query would return a single result with the value of 84 as the total area of all of the Box instances.

The DSL supports grouped projections with the `sqlGroupProjection` method.

```
def results = c.list {
  projections {
    sqlGroupProjection 'width, sum(height) as combinedHeightsForThisWidth', 'width', 'combinedHeightsForThisWidth', [INTEGER, INTEGER]
  }
}
```

The first argument to the `sqlGroupProjection` method is the SQL which defines the projections. clause that should be part of the query. That string may be single column name or a comma separated list of Strings which represent column aliases corresponding to the projected values expressed in the `org.hibernate.type.Type` instances which correspond to the projected values expressed in the SQL.

The query above is projecting the combined heights of boxes grouped by width and would return results th

```
[[2, 24], [4, 9]]
```

Each of the inner lists contains 2 values. The first value is a box width and the second value is the sum of width.

Using SQL Restrictions

You can access Hibernate's SQL Restrictions capabilities.

```
def c = Person.createCriteria()
def peopleWithShortFirstNames = c.list {
    sqlRestriction "char_length(first_name) <= 4"
}
```

SQL Restrictions may be parameterized to deal with SQL injection vulnerabilities related to dynamic restri

```
def c = Person.createCriteria()
def peopleWithShortFirstNames = c.list {
    sqlRestriction "char_length(first_name) < ? AND char_length(first_name) > ?",
}
```



Note that the parameter there is SQL. The `first_name` attribute referenced in the example is a database attribute, not the object model like in HQL queries. The `Person` property named `first_name` refers to the `first_name` column in the database and you must refer to that in the `sqlRestrictions`.

Also note that the SQL used here is not necessarily portable across databases.

Using Scrollable Results

You can use Hibernate's [ScrollableResults](#) feature by calling the scroll method:

```
def results = crit.scroll {
    maxResults(10)
}
def f = results.first()
def l = results.last()
def n = results.next()
def p = results.previous()

def future = results.scroll(10)
def accountNumber = results.getLong('number')
```

To quote the documentation of Hibernate ScrollableResults:

A result iterator that allows moving around within the results by arbitrary increments. The Query , to the JDBC PreparedStatement / ResultSet pattern and the semantics of methods of this interface a on ResultSet.

Contrary to JDBC, columns of results are numbered from zero.

Setting properties in the Criteria instance

If a node within the builder tree doesn't match a particular criterion it will attempt to set a property on the all the properties in this class. This example calls `setMaxResults` and `setFirstResult` on the [Crit](#)

```
import org.hibernate.FetchMode as FM
...
def results = c.list {
    maxResults(10)
    firstResult(50)
    fetchMode("aRelationship", FM.JOIN)
}
```

Querying with Eager Fetching


In the section on [Eager and Lazy Fetching](#) we discussed how to declaratively specify fetching to avoid the be achieved using a criteria query:

```
def criteria = Task.createCriteria()
def tasks = criteria.list{
    eq "assignee.id", task.assignee.id
    join 'assignee'
    join 'project'
    order 'priority', 'asc'
}
```

Notice the usage of the `join` method: it tells the criteria API to use a `JOIN` to fetch the named association not to use this for one-to-many associations though, because you will most likely end up with duplicate res

```
import org.hibernate.FetchMode as FM
...
def results = Airport.withCriteria {
    eq "region", "EMEA"
    fetchMode "flights", FM.SELECT
}
```

Although this approach triggers a second query to get the `flights` association, you will get reliable resul

 `fetchMode` and `join` are general settings of the query and can only be specified at the them inside projections or association constraints.

An important point to bear in mind is that if you include associations in the query constraints, those associ example, in this query:

```
def results = Airport.withCriteria {
    eq "region", "EMEA"
    flights {
        like "number", "BA%"
    }
}
```

the `flights` collection would be loaded eagerly via a join even though the fetch mode has not been expli

Method Reference

If you invoke the builder with no method name such as:

```
c { ... }
```

The build defaults to listing all the results and hence the above is equivalent to:

```
c.list { ... }
```

Method	Description
list	This is the default method. It returns all matching rows.
get	Returns a unique result set, i.e. just one row. The criteria has to be formed that way, that it is not confused with a limit to just the first row.
scroll	Returns a scrollable result set.
listDistinct	If subqueries or associations are used, one may end up with the same row multiple times in the result set. This method returns a unique result set and is equivalent to DISTINCT_ROOT_ENTITY of the CriteriaSpecification class.
count	Returns the number of matching rows.

Combining Criteria

You can combine multiple criteria closures in the following way:

```
def emeaCriteria = {  
    eq "region", "EMEA"  
}  
  
def results = Airport.withCriteria {  
    emeaCriteria.delegate = delegate  
    emeaCriteria()  
    flights {  
        like "number", "BA%"  
    }  
}
```

This technique requires that each criteria must refer to the same domain class (i.e. Airport). A more flexible approach is described in the following section.

7.4.4 Detached Criteria

Detached Criteria are criteria queries that are not associated with any given database session/connection queries have many uses including allowing you to create common reusable criteria queries, execute subque

Building Detached Criteria Queries

The primary point of entry for using the Detached Criteria is the `grails.gorm.DetachedCriteria` argument to its constructor:

```
import grails.gorm.*
...
def criteria = new DetachedCriteria(Person)
```

Once you have obtained a reference to a detached criteria instance you can execute [where](#) queries or criteria build a normal criteria query you can use the `build` method:

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
```

Note that methods on the `DetachedCriteria` instance **do not** mutate the original object but instead use the return value of the `build` method to obtain the mutated criteria object:

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
def bartQuery = criteria.build {
    eq 'firstName', 'Bart'
}
```

Executing Detached Criteria Queries

Unlike regular criteria, Detached Criteria are lazy, in that no query is executed at the point of definition constructed then there are a number of useful query methods which are summarized in the table below:

Method	Description
list	List all matching entities
get	Return a single matching result
count	Count all matching records
exists	Return true if any matching records exist
deleteAll	Delete all matching records
updateAll(Map)	Update all matching records with the given properties

As an example the following code will list the first 4 matching records sorted by the `firstName` property

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
def results = criteria.list(max:4, sort:"firstName")
```

You can also supply additional criteria to the list method:

```
def results = criteria.list(max:4, sort:"firstName") {
    gt 'age', 30
}
```

To retrieve a single result you can use the `get` or `find` methods (which are synonyms):

```
Person p = criteria.find() // or criteria.get()
```

The `DetachedCriteria` class itself also implements the `Iterable` interface which means that it can

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
criteria.each {
    println it.firstName
}
```

In this case the query is only executed when the each method is called. The same applies to all other Groovy methods. You can also execute dynamic finders on DetachedCriteria just like on domain classes. For example

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
def bart = criteria.findByFirstName("Bart")
```

Using Detached Criteria for Subqueries

Within the context of a regular criteria query you can use DetachedCriteria to execute subquery. For example, to find people older than the average age the following query will accomplish that:

```
def results = Person.withCriteria {
    gt "age", new DetachedCriteria(Person).build {
        projections {
            avg "age"
        }
    }
    order "firstName"
}
```

Notice that in this case the subquery class is the same as the original criteria query class (i.e. Person) and

```
def results = Person.withCriteria {
  gt "age", {
    projections {
      avg "age"
    }
  }
  order "firstName"
}
```

If the subquery class differs from the original criteria query then you will have to use the original syntax.

In the previous example the projection ensured that only a single result was returned (the average age). If you are using different criteria methods that need to be used to compare the result. For example to find all the people whose age is between 18 and 65 can be used:

```
def results = Person.withCriteria {
  gtAll "age", {
    projections {
      property "age"
    }
  }
  between 'age', 18, 65
}
order "firstName"
```

The following table summarizes criteria methods for operating on subqueries that return multiple results:

Method	Description
gtAll	greater than all subquery results
geAll	greater than or equal to all subquery results
ltAll	less than all subquery results
leAll	less than or equal to all subquery results
eqAll	equal to all subquery results
neAll	not equal to all subquery results

Batch Operations with Detached Criteria

The `DetachedCriteria` class can be used to execute batch operations such as batch updates and delete. For example, to delete all people with the surname "Simpson" to have the surname "Bloggs":

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
int total = criteria.updateAll(lastName: "Bloggs")
```



Note that one limitation with regards to batch operations is that join queries (queries that are allowed within the DetachedCriteria instance).

To batch delete records you can use the `deleteAll` method:

```
def criteria = new DetachedCriteria(Person).build {
    eq 'lastName', 'Simpson'
}
int total = criteria.deleteAll()
```

7.4.5 Hibernate Query Language (HQL)

GORM classes also support Hibernate's query language HQL, a very complete reference for which can be found in the [Hibernate documentation](#).

GORM provides a number of methods that work with HQL including [find](#), [findAll](#) and [executeQuery](#). An example of using `findAll` is shown below:

```
def results =
    Book.findAll("from Book as b where b.title like 'Lord of the%'")
```

Positional and Named Parameters

In this case the value passed to the query is hard coded, however you can equally use positional parameters

```
def results =
    Book.findAll("from Book as b where b.title like ?", ["The Shi%"])
```

```
def author = Author.findByName("Stephen King")
def books = Book.findAll("from Book as book where book.author = ?",
                        [author])
```

Or even named parameters:

```
def results =
    Book.findAll("from Book as b " +
                "where b.title like :search or b.author like :search",
                [search: "The Shi%"])
```

```
def author = Author.findByName("Stephen King")
def books = Book.findAll("from Book as book where book.author = :author",
                        [author: author])
```

Multiline Queries

-



-As of Grails 3.0.3, Triple-quoted Groovy multiline Strings now work properly with HQL que

Use the line continuation character to separate the query across multiple lines:

```
def results = Book.findAll("\
from Book as b, \
    Author as a \
where b.author = a and a.surname = ?", ['Smith'])
```

or

```
def results = Book.findAll( """
from Book as b,
    Author as a
where b.author = a and a.surname = ?", ['Smith']
""")
```

Pagination and Sorting

You can also perform pagination and sorting whilst using HQL queries. To do so simply specify the pagination and include an "ORDER BY" clause in the HQL:

```
def results =
    Book.findAll("from Book as b where " +
        "b.title like 'Lord of the%' " +
        "order by b.title asc",
        [max: 10, offset: 20])
```

7.5 Advanced GORM Features

The following sections cover more advanced usages of GORM including caching, custom mapping and events.

7.5.1 Events and Auto Timestamping

GORM supports the registration of events as methods that get fired when certain events occurs such as delete of supported events:

- `beforeInsert` - Executed before an object is initially persisted to the database. If you return false, the insert will be cancelled.
- `beforeUpdate` - Executed before an object is updated. If you return false, the update will be cancelled.
- `beforeDelete` - Executed before an object is deleted. If you return false, the delete will be cancelled.
- `beforeValidate` - Executed before an object is validated.
- `afterInsert` - Executed after an object is persisted to the database.
- `afterUpdate` - Executed after an object has been updated.
- `afterDelete` - Executed after an object has been deleted.
- `onLoad` - Executed when an object is loaded from the database.

To add an event simply register the relevant method with your domain class.



Do not attempt to flush the session within an event (such as with `obj.save(flush:true)`). Saving and flushing this will cause a `StackOverflowError`.

Event types

The `beforeInsert` event

Fired before an object is saved to the database

```
class Person {
    private static final Date NULL_DATE = new Date(0)
    String firstName
    String lastName
    Date signupDate = NULL_DATE
    def beforeInsert() {
        if (signupDate == NULL_DATE) {
            signupDate = new Date()
        }
    }
}
```

The `beforeUpdate` event

Fired before an existing object is updated

```
class Person {
    def securityService
    String firstName
    String lastName
    String lastUpdatedBy
    static constraints = {
        lastUpdatedBy nullable: true
    }
    def beforeUpdate() {
        lastUpdatedBy = securityService.currentAuthenticatedUsername()
    }
}
```

The `beforeDelete` event

Fired before an object is deleted.

```
class Person {
    String name

    def beforeDelete() {
        ActivityTrace.withNewSession {
            new ActivityTrace(eventName: "Person Deleted", data: name).save()
        }
    }
}
```

Notice the usage of `withNewSession` method above. Since events are triggered whilst Hibernate is flush and `delete()` won't result in objects being saved unless you run your operations with a new Session.

Fortunately the `withNewSession` method lets you share the same transactional JDBC connection even when you create a new Session.

The beforeValidate event

Fired before an object is validated.

```
class Person {
    String name

    static constraints = {
        name size: 5..45
    }

    def beforeValidate() {
        name = name?.trim()
    }
}
```

The `beforeValidate` method is run before any validators are run.



Validation may run more often than you think. It is triggered by the `validate()` and `save()` methods, but it is also typically triggered just before the view is rendered as well. So when writing `beforeValidate` implementations, make sure that they can handle being called multiple times with the same property names.

GORM supports an overloaded version of `beforeValidate` which accepts a `List` parameter which contains the property names of the objects about to be validated. This version of `beforeValidate` will be called when the `validate` method is called with property names as an argument.

```

class Person {
  String name
  String town
  Integer age

  static constraints = {
    name size: 5..45
    age range: 4..99
  }

  def beforeValidate(List propertiesBeingValidated) {
    // do pre validation work based on propertiesBeingValidated
  }
}

def p = new Person(name: 'Jacob Brown', age: 10)
p.validate(['age', 'name'])

```



Note that when `validate` is triggered indirectly because of a call to the `save` method then `propertiesBeingValidated` will be `null` instead of a `List` containing all of the property names.

Either or both versions of `beforeValidate` may be defined in a domain class. GORM will prefer the `List` version but will fall back on the no-arg version if the `List` version does not exist. Likewise, GORM will prefer the no-arg `validate` but will fall back on the `List` version if the no-arg version does not exist. In that case, `null`

The onLoad/beforeLoad event

Fired immediately before an object is loaded from the database:

```

class Person {
  String name
  Date dateCreated
  Date lastUpdated

  def onLoad() {
    log.debug "Loading ${id}"
  }
}

```

`beforeLoad()` is effectively a synonym for `onLoad()`, so only declare one or the other.

The afterLoad event

Fired immediately after an object is loaded from the database:

```
class Person {  
    String name  
    Date dateCreated  
    Date lastUpdated  
  
    def afterLoad() {  
        name = "I'm loaded"  
    }  
}
```

Custom Event Listeners

As of Grails 2.0 there is a new API for plugins and applications to register and listen for persistence events. This API works for other persistence plugins such as the [MongoDB plugin for GORM](#).

To use this API you need to subclass `AbstractPersistenceEventListener` (in package `org.springframework.data.gorm.events`) and implement the methods `onPersistenceEvent` and `supportsEventType`. You also must provide a simple implementation. The simplest possible implementation can be seen below:

```

public MyPersistenceListener(final Datastore datastore) {
    super(datastore)
}

@Override
protected void onPersistenceEvent(final AbstractPersistenceEvent event) {
    switch(event.eventType) {
        case PreInsert:
            println "PRE INSERT ${event.entityObject}"
            break
        case PostInsert:
            println "POST INSERT ${event.entityObject}"
            break
        case PreUpdate:
            println "PRE UPDATE ${event.entityObject}"
            break;
        case PostUpdate:
            println "POST UPDATE ${event.entityObject}"
            break;
        case PreDelete:
            println "PRE DELETE ${event.entityObject}"
            break;
        case PostDelete:
            println "POST DELETE ${event.entityObject}"
            break;
        case PreLoad:
            println "PRE LOAD ${event.entityObject}"
            break;
        case PostLoad:
            println "POST LOAD ${event.entityObject}"
            break;
    }
}

@Override
public boolean supportsEventType(Class<? extends ApplicationEvent> eventType) {
    return true
}

```

The AbstractPersistenceEvent class has many subclasses (PreInsertEvent, PostInsertEvent, etc.) specific to the event. A cancel() method is also provided on the event which allows you to veto an insert or update.

Once you have created your event listener you need to register it with the ApplicationContext. This

```

def grailsApplication

def init = {
    def applicationContext = grailsApplication.mainContext
    applicationContext.eventTriggeringInterceptor.datastores.each { k, datastore
        applicationContext.addApplicationListener new MyPersistenceListener(datastore)
    }
}

```

or use this in a plugin:

```
def doWithApplicationContext = { applicationContext ->
    grailsApplication.mainContext.eventTriggeringInterceptor.datastores.each { k,
        applicationContext.addApplicationListener new MyPersistenceListener(datas
    }
}
```

Hibernate Events

It is generally encouraged to use the non-Hibernate specific API described above, but if you need access define custom Hibernate-specific event listeners.

You can also register event handler classes in an application's `grails-app/conf/spring/resources.groovy` closure in a plugin descriptor by registering a Spring bean named `hibernateEventListeners`. This specifies the listeners to register for various Hibernate events.

The values of the Map are instances of classes that implement one or more Hibernate listener interfaces. You can register multiple interfaces, or one concrete class per interface, or any combination. The valid Map keys and corres

Name	Interface
auto-flush	AutoFlushEventListener
merge	MergeEventListener
create	PersistEventListener
create-onflush	PersistEventListener
delete	DeleteEventListener
dirty-check	DirtyCheckEventListener
evict	EvictEventListener
flush	FlushEventListener
flush-entity	FlushEntityEventListener
load	LoadEventListener
load-collection	InitializeCollectionEventListener
lock	LockEventListener
refresh	RefreshEventListener
replicate	ReplicateEventListener
save-update	SaveOrUpdateEventListener
save	SaveOrUpdateEventListener
update	SaveOrUpdateEventListener
pre-load	PreLoadEventListener
pre-update	PreUpdateEventListener
pre-delete	PreDeleteEventListener
pre-insert	PreInsertEventListener
pre-collection-recreate	PreCollectionRecreateEventListener
pre-collection-remove	PreCollectionRemoveEventListener
pre-collection-update	PreCollectionUpdateEventListener
post-load	PostLoadEventListener
post-update	PostUpdateEventListener
post-delete	PostDeleteEventListener
post-insert	PostInsertEventListener
post-commit-update	PostUpdateEventListener
post-commit-delete	PostDeleteEventListener
post-commit-insert	PostInsertEventListener
post-collection-recreate	PostCollectionRecreateEventListener
post-collection-remove	PostCollectionRemoveEventListener
post-collection-update	PostCollectionUpdateEventListener

For example, you could register a class `AuditEventListener` which implements `PostUpdateEventListener`, and `PostDeleteEventListener` using the following in an applic

```
beans = {
    auditListener(AuditEventListener)
    hibernateEventListeners(HibernateEventListeners) {
        listenerMap = ['post-insert': auditListener,
                       'post-update': auditListener,
                       'post-delete': auditListener]
    }
}
```

or use this in a plugin:

```
def doWithSpring = {
    auditListener(AuditEventListener)
    hibernateEventListeners(HibernateEventListeners) {
        listenerMap = ['post-insert': auditListener,
                       'post-update': auditListener,
                       'post-delete': auditListener]
    }
}
```

Automatic timestamping

If you define a `dateCreated` property it will be set to the current date for you when you create a new instance. If you define a `lastUpdated` property it will be automatically be updated for you when you change persistent instances.

If this is not the behaviour you want you can disable this feature with:

```
class Person {
    Date dateCreated
    Date lastUpdated
    static mapping = {
        autoTimestamp false
    }
}
```



If you have `nullable: false` constraints on either `dateCreated` or `lastUpdated` fail validation - probably not what you want. Omit constraints from these properties unless you want timestamping.

7.5.2 Custom ORM Mapping

Grails domain classes can be mapped onto many legacy schemas with an Object Relational Mapping DSL. This section takes you through what is possible with the ORM DSL.



None of this is necessary if you are happy to stick to the conventions defined by GORM for versioning and so on. You only need this functionality if you need to tailor the way GORM maps onto the database.

Custom mappings are defined using a static mapping block defined within your domain class:

```
class Person {
    ...
    static mapping = {
        version false
        autoTimestamp false
    }
}
```

You can also configure global mappings in `application.groovy` (or an external config file) using this DSL:

```
grails.gorm.default.mapping = {
    version false
    autoTimestamp false
}
```

It has the same syntax as the standard mapping block but it applies to all your domain classes! You can also override the mapping block of a domain class.

7.5.2.1 Table and Column Names

Table names

The database table name which the class maps to can be customized using the `table` method:


```
class Person {
    ...
    static mapping = {
        table 'people'
    }
}
```

In this case the class would be mapped to a table called `people` instead of the default name of `person`.

Column names

It is also possible to customize the mapping for individual columns onto the database. For example to chan

```
class Person {
    String firstName
    static mapping = {
        table 'people'
        firstName column: 'First_Name'
    }
}
```

Here `firstName` is a dynamic method within the mapping Closure that has a single Map parameter persistent field, the parameter values (in this case just "column") are used to configure the mapping for t

Column type

GORM supports configuration of Hibernate types with the DSL using the type attribute. This includes spe [org.hibernate.usertype.UserType](#) interface, which allows complete customization of how a type is persisted you could use it as follows:

```
class Address {
    String number
    String postCode
    static mapping = {
        postCode type: PostCodeType
    }
}
```

Alternatively if you just wanted to map it to one of Hibernate's basic types other than the default chosen by

```
class Address {
    String number
    String postCode

    static mapping = {
        postCode type: 'text'
    }
}
```

This would make the `postCode` column map to the default large-text type for the database you're using (1). See the Hibernate documentation regarding [Basic Types](#) for further information.

Many-to-One/One-to-One Mappings

In the case of associations it is also possible to configure the foreign keys used to map associations. In the this is exactly the same as any regular column. For example consider the following:

```
class Person {
    String firstName
    Address address

    static mapping = {
        table 'people'
        firstName column: 'First_Name'
        address column: 'Person_Address_Id'
    }
}
```

By default the `address` association would map to a foreign key column called `address_id`. By using of the foreign key column to `Person_Address_Id`.

One-to-Many Mapping

With a bidirectional one-to-many you can change the foreign key column used by changing the column in the example in the previous section on one-to-one associations. However, with unidirectional association itself. For example given a unidirectional one-to-many relationship between `Person` and foreign key in the `address` table:

```

class Person {
  String firstName
  static hasMany = [addresses: Address]
  static mapping = {
    table 'people'
    firstName column: 'First_Name'
    addresses column: 'Person_Address_Id'
  }
}

```

If you don't want the column to be in the address table, but instead some intermediate join table you can

```

class Person {
  String firstName
  static hasMany = [addresses: Address]
  static mapping = {
    table 'people'
    firstName column: 'First_Name'
    addresses joinTable: [name: 'Person_Addresses',
                          key: 'Person_Id',
                          column: 'Address_Id']
  }
}

```

Many-to-Many Mapping

Grails, by default maps a many-to-many association using a join table. For example consider this many-to-

```

class Group {
  ...
  static hasMany = [people: Person]
}

```

```

class Person {
    ...
    static belongsTo = Group
    static hasMany = [groups: Group]
}

```

In this case Grails will create a join table called `group_person` containing foreign keys called `person` and `group` tables. To change the column names you can specify a column within the mappings for each class.

```

class Group {
    ...
    static mapping = {
        people column: 'Group_Person_Id'
    }
}
class Person {
    ...
    static mapping = {
        groups column: 'Group_Group_Id'
    }
}

```

You can also specify the name of the join table to use:

```

class Group {
    ...
    static mapping = {
        people column: 'Group_Person_Id',
        joinTable: 'PERSON_GROUP_ASSOCIATIONS'
    }
}
class Person {
    ...
    static mapping = {
        groups column: 'Group_Group_Id',
        joinTable: 'PERSON_GROUP_ASSOCIATIONS'
    }
}

```


7.5.2.2 Caching Strategy

Setting up caching

[Hibernate](#) features a second-level cache with a customizable cache provider. The `grails-app/conf/application.yml` file as follows:

```
hibernate:
  cache:
    use_second_level_cache: true
    provider_class: net.sf.ehcache.hibernate.EhCacheProvider
    region:
      factory_class: org.hibernate.cache.ehcache.EhCacheRegionFactory
```

You can customize any of these settings, for example to use a distributed caching mechanism.

 For further reading on caching and in particular Hibernate's second-level cache, refer to the subject.

Caching instances

Call the `cache` method in your mapping block to enable caching with the default settings:

```
class Person {
  ...
  static mapping = {
    table 'people'
    cache true
  }
}
```

This will configure a 'read-write' cache that includes both lazy and non-lazy properties. You can customize

```
class Person {
  ...
  static mapping = {
    table 'people'
    cache usage: 'read-only', include: 'non-lazy'
  }
}
```

Caching associations

As well as the ability to use Hibernate's second level cache to cache instances you can also cache collection

```
class Person {  
  String firstName  
  static hasMany = [addresses: Address]  
  static mapping = {  
    table 'people'  
    version false  
    addresses column: 'Address', cache: true  
  }  
}
```

```
class Address {  
  String number  
  String postCode  
}
```

This will enable a 'read-write' caching mechanism on the addresses collection. You can also use:

```
cache: 'read-write' // or 'read-only' or 'transactional'
```

to further configure the cache usage.

Caching Queries

You can cache queries such as dynamic finders and criteria. To do so using a dynamic finder you can pass

```
def person = Person.findByFirstName("Fred", [cache: true])
```



In order for the results of the query to be cached, you must enable caching in your mapping section.

You can also cache criteria queries:

```
def people = Person.withCriteria {  
    like('firstName', 'Fr%')  
    cache true  
}
```

Cache usages

Below is a description of the different cache settings and their usages:

- `read-only` - If your application needs to read but never modify instances of a persistent class, a `read-only` cache might be appropriate.
- `read-write` - If the application needs to update data, a `read-write` cache might be appropriate.
- `nonstrict-read-write` - If the application only occasionally needs to update data (i.e. if it is update the same item simultaneously) and strict transaction isolation is not required, a `nonstrict-read-write` cache might be appropriate.
- `transactional` - The `transactional` cache strategy provides support for fully transactional a cache may only be used in a JTA environment and you must specify `hibernate.transactional` in the `grails-app/conf/application.groovy` file's hibernate config.

7.5.2.3 Inheritance Strategies

By default GORM classes use `table-per-hierarchy` inheritance mapping. This has the disadvantage of a `table-per-hierarchy` constraint applied to them at the database level. If you would prefer to use a `table-per-subclass` inheritance mapping, you can specify it in the mapping section of the root class.

```
class Payment {  
    Integer amount  
  
    static mapping = {  
        tablePerHierarchy false  
    }  
}  
  
class CreditCardPayment extends Payment {  
    String cardNumber  
}
```

The mapping of the root `Payment` class specifies that it will not be using `table-per-hierarchy` mapping.

7.5.2.4 Custom Database Identity

You can customize how GORM generates identifiers for the database using the DSL. By default GORM generates ids. This is by far the best approach, but there are still many schemas that have different approaches.

To deal with this Hibernate defines the concept of an id generator. You can customize the id generator and

```
class Person {  
    ...  
    static mapping = {  
        table 'people'  
        version false  
        id generator: 'hilo',  
        params: [table: 'hi_value',  
                 column: 'next_value',  
                 max_lo: 100]  
    }  
}
```

In this case we're using one of Hibernate's built in 'hilo' generators that uses a separate table to generate ids



For more information on the different Hibernate generators refer to the [Hibernate reference documentation](#)

Although you don't typically specify the id field (Grails adds it for you) you can still configure its mapping. You can customise the column for the id property you can do:

```
class Person {  
    ...  
    static mapping = {  
        table 'people'  
        version false  
        id column: 'person_id'  
    }  
}
```

7.5.2.5 Composite Primary Keys

GORM supports the concept of composite identifiers (identifiers composed from 2 or more properties) available to you if you need it:


```

import org.apache.commons.lang.builder.HashCodeBuilder

class Person implements Serializable {
    String firstName
    String lastName

    boolean equals(other) {
        if (!(other instanceof Person)) {
            return false
        }

        other.firstName == firstName && other.lastName == lastName
    }

    int hashCode() {
        def builder = new HashCodeBuilder()
        builder.append firstName
        builder.append lastName
        builder.toHashCode()
    }

    static mapping = {
        id composite: ['firstName', 'lastName']
    }
}

```

The above will create a composite id of the `firstName` and `lastName` properties of the `Person` class. 7 of the object itself:

```

def p = Person.get(new Person(firstName: "Fred", lastName: "Flintstone"))
println p.firstName

```

Domain classes mapped with composite primary keys must implement the `Serializable` interface methods, using the properties in the composite key for the calculations. The example above uses a `HashCodeBuilder` to implement it yourself.

Another important consideration when using composite primary keys is associations. If for example you have keys are stored in the associated table then 2 columns will be present in the associated table.

For example consider the following domain class:

```

class Address {
    Person person
}

```

In this case the address table will have an additional two columns called `person_first_name` and the mapping of these columns then you can do so using the following technique:

```
class Address {
    Person person
    static mapping = {
        columns {
            person {
                column name: "FirstName"
                column name: "LastName"
            }
        }
    }
}
```

7.5.2.6 Database Indices

To get the best performance out of your queries it is often necessary to tailor the table index definitions matter of monitoring usage patterns of your queries. With GORM's DSL you can specify which columns a

```
class Person {
    String firstName
    String address
    static mapping = {
        table 'people'
        version false
        id column: 'person_id'
        firstName column: 'First_Name', index: 'Name_Idx'
        address column: 'Address', index: 'Name_Idx,Address_Index'
    }
}
```

Note that you cannot have any spaces in the value of the `index` attribute; in this example `index: 'Name_Idx,Address_Index'` is correct, `index: 'Name_Idx Address_Index'` is an error.

7.5.2.7 Optimistic Locking and Versioning

As discussed in the section on [Optimistic and Pessimistic Locking](#), by default GORM uses optimistic property into every class which is in turn mapped to a `version` column at the database level.

If you're mapping to a legacy schema that doesn't have version columns (or there's some other reason) disable this with the `version` method:

```
class Person {
    ...
    static mapping = {
        table 'people'
        version false
    }
}
```



If you disable optimistic locking you are essentially on your own with regards to concurrent risk of users losing data (due to data overriding) unless you use [pessimistic locking](#)

Version columns types

By default Grails maps the `version` property as a `Long` that gets incremented by one each time an instance is updated. You can also use a `Timestamp`, for example:

```
import java.sql.Timestamp

class Person {

    ...
    Timestamp version

    static mapping = {
        table 'people'
    }
}
```

There's a slight risk that two updates occurring at nearly the same time on a fast server can end up with the last update overwriting the first. One benefit of using a `Timestamp` instead of a `Long` is that you combine the optimistic locking and last-wins semantics.

7.5.2.8 Eager and Lazy Fetching

Lazy Collections

As discussed in the section on [Eager and Lazy fetching](#), GORM collections are lazily loaded by default by the `GrailsGORMPlugin` DSL. There are several options available to you, but the most common ones are:

- `lazy: false`
- `fetch: 'join'`

and they're used like this:

```

class Person {
  String firstName
  Pet pet
  static hasMany = [addresses: Address]
  static mapping = {
    addresses lazy: false
    pet fetch: 'join'
  }
}

```

```

class Address {
  String street
  String postCode
}

```

```

class Pet {
  String name
}

```

The first option, `lazy: false`, ensures that when a `Person` instance is loaded, its `addresses` collection is loaded with a `SELECT`. The second option is basically the same, except the collection is loaded with a `JOIN` rather than the number of queries, so `fetch: 'join'` is the more appropriate option. On the other hand, it could lead to a domain model and data result in more and larger results than would otherwise be necessary.

For more advanced users, the other settings available are:

1. `batchSize: N`
2. `lazy: false, batchSize: N`

where `N` is an integer. These let you fetch results in batches, with one query per batch. As a simple example

```
class Person {
  String firstName
  Pet pet
  static mapping = {
    pet batchSize: 5
  }
}
```

If a query returns multiple `Person` instances, then when we access the first `pet` property, Hibernate will get the same behaviour with eager loading by combining `batchSize` with the `lazy: false` option. [Y](#) [Hibernate user guide](#) and this [primer on fetching strategies](#). Note that ORM DSL does not currently support

Lazy Single-Ended Associations

In GORM, one-to-one and many-to-one associations are by default lazy. Non-lazy single ended associations because each non-lazy association will result in an extra `SELECT` statement. If the associated entity of queries grows significantly!

Use the same technique as for lazy collections to make a one-to-one or many-to-one association non-lazy/e

```
class Person {
  String firstName
}
```

```
class Address {
  String street
  String postCode
  static belongsTo = [person: Person]
  static mapping = {
    person lazy: false
  }
}
```

Here we configure GORM to load the associated `Person` instance (through the `person` property) whene

Lazy Single-Ended Associations and Proxies

Hibernate uses runtime-generated proxies to facilitate single-ended lazy associations; Hibernate dynamic proxy.

Consider the previous example but with a lazily-loaded person association: Hibernate will set the pet to a Person. When you call any of the getters (except for the id property) or setters on that proxy, Hibernate

Unfortunately this technique can produce surprising results. Consider the following example classes:

```
class Pet {  
    String name  
}
```

```
class Dog extends Pet {  
}
```

```
class Person {  
    String name  
    Pet pet  
}
```

and assume that we have a single Person instance with a Dog as the pet. The following code will work

```
def person = Person.get(1)  
assert person.pet instanceof Dog  
assert Pet.get(person.petId) instanceof Dog
```

But this won't:

```
def person = Person.get(1)
assert person.pet instanceof Dog
assert Pet.list()[0] instanceof Dog
```

The second assertion fails, and to add to the confusion, this will work:

```
assert Pet.list()[0] instanceof Dog
```

What's going on here? It's down to a combination of how proxies work and the guarantees that the Hibernate instance, Hibernate creates a proxy for its `pet` relation and attaches it to the session. Once that happens, query, a `get()`, or the `pet` relation *within the same session*, Hibernate gives you the proxy.

Fortunately for us, GORM automatically unwraps the proxy when you use `get()` and `findBy*`, or when you don't have to worry at all about proxies in the majority of cases. But GORM doesn't do that for objects returned by `list()` and `findAllBy*`. However, if Hibernate hasn't attached the proxy to the session, those queries from the last example work.

You can protect yourself to a degree from this problem by using the `instanceOf` method by GORM:

```
def person = Person.get(1)
assert Pet.list()[0].instanceOf(Dog)
```

However, it won't help here if casting is involved. For example, the following code will throw a `ClassCastException` because `pet` is a proxy instance with a class that is neither `Dog` nor a sub-class of `Dog`:

```
def person = Person.get(1)
Dog pet = Pet.list()[0]
```

Of course, it's best not to use static types in this situation. If you use an untyped variable for the `pet` instead of `Dog`, you can avoid these problems.

These days it's rare that you will come across this issue, but it's best to be aware of it just in case. At least able to work around it.

7.5.2.9 Custom Cascade Behaviour

As described in the section on [cascading updates](#), the primary mechanism to control the way updates and is the static [belongsTo](#) property.

However, the ORM DSL gives you complete access to Hibernate's [transitive persistence](#) capabilities using

Valid settings for the cascade attribute include:

- `merge` - merges the state of a detached association
- `save-update` - cascades only saves and updates to an association
- `delete` - cascades only deletes to an association
- `lock` - useful if a pessimistic lock should be cascaded to its associations
- `refresh` - cascades refreshes to an association
- `evict` - cascades evictions (equivalent to `discard()` in GORM) to associations if set
- `all` - cascade *all* operations to associations
- `all-delete-orphan` - Applies only to one-to-many associations and indicates that when a child is automatically deleted. Children are also deleted when the parent is.



It is advisable to read the section in the Hibernate documentation on [transitive persistence](#) to of the different cascade styles and recommendations for their usage

To specify the cascade attribute simply define one or more (comma-separated) of the aforementioned settir

```
class Person {
  String firstName
  static hasMany = [addresses: Address]
  static mapping = {
    addresses cascade: "all-delete-orphan"
  }
}
```



```
class Address {
    String street
    String postCode
}
```

7.5.2.10 Custom Hibernate Types

You saw in an earlier section that you can use composition (with the embedded property) to break a similar effect with Hibernate's custom user types. These are not domain classes themselves, but plain Java a corresponding "meta-type" class that implements org.hibernate.usertype.UserType.

The [Hibernate reference manual](#) has some information on custom types, but here we will focus on how to at a simple domain class that uses an old-fashioned (pre-Java 1.5) type-safe enum class:

```
class Book {
    String title
    String author
    Rating rating

    static mapping = {
        rating type: RatingUserType
    }
}
```

All we have done is declare the `rating` field the enum type and set the property's type in the custom implementation. That's all you have to do to start using your custom type. If you want, you can also use change the column name and "index" to add it to an index.

Custom types aren't limited to just a single column - they can be mapped to as many columns as you want by specifying the mapping what columns to use, since Hibernate can only use the property name for a single column. Fortunately, you can map a property using this syntax:

```

class Book {
  String title
  Name author
  Rating rating

  static mapping = {
    author type: NameUserType, {
      column name: "first_name"
      column name: "last_name"
    }
    rating type: RatingUserType
  }
}

```

The above example will create "first_name" and "last_name" columns for the author property. You'll be using the normal column/property mapping attributes in the column definitions. For example:

```

column name: "first_name", index: "my_idx", unique: true

```

The column definitions do *not* support the following attributes: type, cascade, lazy, cache, and join

One thing to bear in mind with custom types is that they define the *SQL types* for the corresponding database columns. When configuring them yourself, but what happens if you have a legacy database that uses a different SQL type than the column's SQL type using the `sqlType` attribute:

```

class Book {
  String title
  Name author
  Rating rating

  static mapping = {
    author type: NameUserType, {
      column name: "first_name", sqlType: "text"
      column name: "last_name", sqlType: "text"
    }
    rating type: RatingUserType, sqlType: "text"
  }
}

```

Mind you, the SQL type you specify needs to still work with the custom type. So overriding a default of "yes_no" with "yes_no" isn't going to work.

7.5.2.11 Derived Properties

A derived property is one that takes its value from a SQL expression, often but not necessarily based on other properties. Consider a Product class like this:

```
class Product {
    Float price
    Float taxRate
    Float tax
}
```

If the tax property is derived based on the value of price and taxRate properties then it is probably not possible to derive the value of a derived property. This may be expressed in the ORM DSL like this:

```
class Product {
    Float price
    Float taxRate
    Float tax

    static mapping = {
        tax formula: 'PRICE * TAX_RATE'
    }
}
```

Note that the formula expressed in the ORM DSL is SQL so references to other properties should relate to the database, which is why the example refers to PRICE and TAX_RATE instead of price and taxRate.

With that in place, when a Product is retrieved with something like `Product.get(42)`, the SQL that is generated is like this:

```
select
    product0_.id as id1_0_,
    product0_.version as version1_0_,
    product0_.price as price1_0_,
    product0_.tax_rate as tax4_1_0_,
    product0_.PRICE * product0_.TAX_RATE as formula1_0_
from
    product product0_
where
    product0_.id=?
```

Since the `tax` property is derived at runtime and not stored in the database it might seem that the same effect of `getTax()` to the `Product` class that simply returns the product of the `taxRate` and `price` properties: the ability query the database based on the value of the `tax` property. Using a derived property allows you to have a `tax` value greater than 21.12 you could execute a query like this:

```
Product.findAllByTaxGreaterThan(21.12)
```

Derived properties may be referenced in the Criteria API:

```
Product.withCriteria {  
    gt 'tax', 21.12f  
}
```

The SQL that is generated to support either of those would look something like this:

```
select  
    this_.id as id1_0_,  
    this_.version as version1_0_,  
    this_.price as price1_0_,  
    this_.tax_rate as tax4_1_0_,  
    this_.PRICE * this_.TAX_RATE as formula1_0_  
from  
    product this_  
where  
    this_.PRICE * this_.TAX_RATE>?
```



Because the value of a derived property is generated in the database and depends on the existing properties may not have GORM constraints applied to them. If constraints are specified for a derived property they are ignored.

7.5.2.12 Custom Naming Strategy

By default Grails uses Hibernate's `ImprovedNamingStrategy` to convert domain class names and converting from camel-cased Strings to ones that use underscores as word separators. You can customize this by specifying a different `NamingStrategy` class to use.

Configure the class name to be used in `grails-app/conf/application.groovy` in the `hibernate` section:

```

dataSource {
    pooled = true
    dbCreate = "create-drop"
    ...
}
hibernate {
    cache.use_second_level_cache = true
    ...
    naming_strategy = com.myco.myproj.CustomNamingStrategy
}

```

You can also specify the name of the class and it will be loaded for you:

```

hibernate {
    ...
    naming_strategy = 'com.myco.myproj.CustomNamingStrategy'
}

```

A third option is to provide an instance if there is some configuration required beyond calling the default c

```

hibernate {
    ...
    def strategy = new com.myco.myproj.CustomNamingStrategy()
    // configure as needed
    naming_strategy = strategy
}

```

You can use an existing class or write your own, for example one that prefixes table names and column na

```

package com.myco.myproj

import org.hibernate.cfg.ImprovedNamingStrategy
import org.hibernate.util.StringHelper

class CustomNamingStrategy extends ImprovedNamingStrategy {

    String classToTableName(String className) {
        "table_" + StringHelper.unqualify(className)
    }

    String propertyToColumnName(String propertyName) {
        "col_" + StringHelper.unqualify(propertyName)
    }
}

```

7.5.3 Default Sort Order

You can sort objects using query arguments such as those found in the [list](#) method:

```

def airports = Airport.list(sort:'name')

```

However, you can also declare the default sort order for a collection in the mapping:

```

class Airport {
    ...
    static mapping = {
        sort "name"
    }
}

```

The above means that all collections of `Airport` instances will by default be sorted by the airport name this syntax:

```
class Airport {
  ...
  static mapping = {
    sort name: "desc"
  }
}
```

Finally, you can configure sorting at the association level:

```
class Airport {
  ...
  static hasMany = [flights: Flight]
  static mapping = {
    flights sort: 'number', order: 'desc'
  }
}
```

In this case, the `flights` collection will always be sorted in descending order of flight number.



These mappings will not work for default unidirectional one-to-many or many-to-many relationships using a join table. See [this issue](#) for more details. Consider using a `SortedSet` or queries with sorting if you need.

7.6 Programmatic Transactions

Grails is built on Spring and uses Spring's Transaction abstraction for dealing with programmatic transactions. Grails is enhanced to make this simpler with the [withTransaction](#) method. This method has a single parameter, a `Spring TransactionStatus` instance.

Here's an example of using `withTransaction` in a controller methods:

```

def transferFunds() {
    Account.withTransaction { status ->
        def source = Account.get(params.from)
        def dest = Account.get(params.to)

        def amount = params.amount.toInteger()
        if (source.active) {
            if (dest.active) {
                source.balance -= amount
                dest.amount += amount
            }
            else {
                status.setRollbackOnly()
            }
        }
    }
}

```

In this example we rollback the transaction if the destination account is not active. Also, if an unchecked Exception, even though Groovy doesn't require that you catch checked exceptions) is thrown during the transaction, it will be rolled back.

You can also use "save points" to rollback a transaction to a particular point in time if you don't want to rollback the entire transaction. This can be achieved through the use of Spring's [SavePointManager](#) interface.

The `withTransaction` method deals with the begin/commit/rollback logic for you within the scope of the transaction.

7.7 GORM and Constraints

Although constraints are covered in the [Validation](#) section, it is important to mention them here as some of the database schema is generated.

Where feasible, Grails uses a domain class's constraints to influence the database columns generated for the domain class.

Consider the following example. Suppose we have a domain model with the following properties:

```

String name
String description

```

By default, in MySQL, Grails would define these columns as

Column	Data Type
name	varchar(255)
description	varchar(255)

But perhaps the business rules for this domain class state that a description can be up to 1000 characters in length. We can define the column as follows *if* we were creating the table with an SQL script.

Column	Data Type
description	TEXT

Chances are we would also want to have some application-based validation to make sure we don't exceed 1000 characters in records. In Grails, we achieve this validation with [constraints](#). We would add the following constraint declaration to our domain class:

```
static constraints = {  
    description maxSize: 1000  
}
```

This constraint would provide both the application-based validation we want and it would also cause the generation of a description of the other constraints that influence schema generation.

Constraints Affecting String Properties

- [inList](#)
- [maxSize](#)
- [size](#)

If either the `maxSize` or the `size` constraint is defined, Grails sets the maximum column length based on the value of the constraint.

In general, it's not advisable to use both constraints on the same domain class property. However, if both constraints are defined, then Grails sets the column length to the minimum of the `maxSize` constraint and the `size` constraint, because any length that exceeds that minimum will result in a validation error.

If the `inList` constraint is defined (and the `maxSize` and the `size` constraints are not defined), then Grails sets the column length to the length of the longest string in the list of valid values. For example, given a list including values "Java" and "Groovy", Grails sets the column length to 6 (i.e., the number of characters in the string "Groovy").

Constraints Affecting Numeric Properties

- [min](#)
- [max](#)
- [range](#)

If the `max`, `min`, or `range` constraint is defined, Grails attempts to set the column precision based on the value of the constraint. (The influence is largely dependent on how Hibernate interacts with the underlying DBMS.)

In general, it's not advisable to combine the pair `min`/`max` and `range` constraints together on the same domain class property. If both constraints are defined, then Grails uses the minimum precision value from the constraints. (Grails uses the maximum precision if it exceeds that minimum precision will result in a validation error.)

- [scale](#)

If the scale constraint is defined, then Grails attempts to set the column [scale](#) based on the constraint numbers (i.e., `java.lang.Float`, `java.lang.Double`, `java.lang.BigDecimal`, or subclass). The success of this attempted influence is largely dependent on how Hibernate interacts with the underlying DB.

The constraints define the minimum/maximum numeric values, and Grails derives the maximum number of digits. That specifying only one of min/ max constraints will not affect schema generation (since there could be a case for example), unless the specified constraint value requires more digits than default Hibernate column precision.

```
someFloatValue max: 1000000, scale: 3
```

would yield:

```
someFloatValue DECIMAL(19, 3) // precision is default
```

but

```
someFloatValue max: 12345678901234567890, scale: 5
```

would yield:

```
someFloatValue DECIMAL(25, 5) // precision = digits in max + scale
```

and

```
someFloatValue max: 100, min: -100000
```

would yield:

```
someFloatValue DECIMAL(8, 2) // precision = digits in min + default scale
```

8 The Web Layer

8.1 Controllers

A controller handles requests and creates or prepares the response. A controller can generate the response (e.g., a view). To create a controller, simply create a class whose name ends with `Controller` in the `grails-app/controllers` package).

The default [URL Mapping](#) configuration ensures that the first part of your controller name is mapped to the URI within the controller name. For example, `BookController` maps to the `/book` URI.

8.1.1 Understanding Controllers and Actions

Creating a controller

Controllers can be created with the [create-controller](#) or [generate-controller](#) command. For example, try running the `create-controller` command in your Grails project:

```
grails create-controller book
```

The command will create a controller at the location `grails-app/controllers/myapp/BookController`.

```
package myapp

class BookController {

    def index() { }
}
```

where "myapp" will be the name of your application, the default package name if one isn't specified.

`BookController` by default maps to the `/book` URI (relative to your application root).



The `create-controller` and `generate-controller` commands are just for convenience. You can easily create controllers using your favorite text editor or IDE.

Creating Actions

A controller can have multiple public action methods; each one maps to a URI:

```
class BookController {
  def list() {
    // do controller logic
    // create model
    return model
  }
}
```

This example maps to the `/book/list` URI by default thanks to the property being named `list`.

Public Methods as Actions

In earlier versions of Grails actions were implemented with Closures. This is still supported, but the preferred way is to use public methods.

Leveraging methods instead of Closure properties has some advantages:

- Memory efficient
- Allow use of stateless controllers (singleton scope)
- You can override actions from subclasses and call the overridden superclass method with `super.actionName()`
- Methods can be intercepted with standard proxying mechanisms, something that is complicated to do with Closures

If you prefer the Closure syntax or have older controller classes created in earlier versions of Grails and want to keep them, you can set the `grails.compile.artefacts.closures.convert` property to `true` in `application.yml`:

```
grails:
  compile:
    artefacts:
      closures:
        convert: true
```

and a compile-time AST transformation will convert your Closures to methods in the generated bytecode.



If a controller class extends some other class which is not defined under the `grails-app` directory, the methods inherited from that class are not converted to controller actions. If the intent is to expose these methods as controller actions the methods may be overridden in the subclass and the subclass method will be converted to a controller action.

The Default Action

A controller has the concept of a default URI that maps to the root URI of the controller, for example `/book`. The URI called when the default URI is requested is dictated by the following rules:

- If there is only one action, it's the default
- If you have an action named `index`, it's the default
- Alternatively you can set it explicitly with the `defaultAction` property:

```
static defaultAction = "list"
```

8.1.2 Controllers and Scopes

Available Scopes

Scopes are hash-like objects where you can store variables. The following scopes are available to controllers:

- [servletContext](#) - Also known as application scope, this scope lets you share state across the entire web application of [ServletContext](#)
- [session](#) - The session allows associating state with a given user and typically uses cookies to associate with an instance of [HttpSession](#)
- [request](#) - The request object allows the storage of objects for the current request only. The request object is an instance of [HttpServletRequest](#)
- [params](#) - Mutable map of incoming request query string or POST parameters
- [flash](#) - See below

Accessing Scopes

Scopes can be accessed using the variable names above in combination with Groovy's array index operator, such as the [HttpServletRequest](#):

```
class BookController {
    def find() {
        def findBy = params["findBy"]
        def appContext = request["foo"]
        def loggedInUser = session["logged_user"]
    }
}
```

You can also access values within scopes using the de-reference operator, making the syntax even more clear.

```

class BookController {
  def find() {
    def findBy = params.findBy
    def appContext = request.foo
    def loggedUser = session.logged_user
  }
}

```

This is one of the ways that Grails unifies access to the different scopes.

Using Flash Scope

Grails supports the concept of [flash](#) scope as a temporary store to make attributes available for this request. After the next request, these attributes are cleared. This is useful for setting a message directly before redirecting, for example:

```

def delete() {
  def b = Book.get(params.id)
  if (!b) {
    flash.message = "User not found for id ${params.id}"
    redirect(action: list)
  }
  ... // remaining code
}

```

When the `list` action is requested, the message value will be in scope and can be used to display an interface. The message is only available in the flash scope after this second request.

Note that the attribute name can be anything you want, and the values are often strings used to display messages.

Scoped Controllers

Newly created applications have the `grails.controllers.defaultScope` property set to a value. You may change this value to any of the supported scopes listed below. If the property is not assigned a value, the default is `prototype`.

Supported controller scopes are:

- `prototype` (default) - A new controller will be created for each request (recommended for actions as methods)
- `session` - One controller is created for the scope of a user session
- `singleton` - Only one instance of the controller ever exists (recommended for actions as methods)

To enable one of the scopes, add a static `scope` property to your class with one of the valid scope values listed above.

```
static scope = "singleton"
```

You can define the default strategy in `application.yml` with the `grails.controllers.default`.

```
grails:
  controllers:
    defaultScope: singleton
```



Use scoped controllers wisely. For instance, we don't recommend having any properties in since they will be shared for *all* requests.

8.1.3 Models and Views

Returning the Model

A model is a Map that the view uses when rendering. The keys within that Map correspond to variable names of ways to return a model. First, you can explicitly return a Map instance:

```
def show() {
  [book: Book.get(params.id)]
}
```



The above does *not* reflect what you should use with the scaffolding views - see the [scaffolding](#)

A more advanced approach is to return an instance of the Spring [ModelAndView](#) class:


```
import org.springframework.web.servlet.ModelAndView

def index() {
    // get some books just for the index page, perhaps your favorites
    def favoriteBooks = ...

    // forward to the list view to show them
    return new ModelAndView("/book/list", [ bookList : favoriteBooks ])
}
```

One thing to bear in mind is that certain variable names can not be used in your model:

- attributes
- application

Currently, no error will be reported if you do use them, but this will hopefully change in a future version of

Selecting the View

In both of the previous two examples there was no code that specified which [view](#) to render. So how does it work in the conventions. Grails will look for a view at the location `grails-app/views/book/show.gsp`

```
class BookController {
    def show() {
        [book: Book.get(params.id)]
    }
}
```

To render a different view, use the [render](#) method:

```
def show() {
    def map = [book: Book.get(params.id)]
    render(view: "display", model: map)
}
```

In this case Grails will attempt to render a view at the location `grails-app/views/book/display` the view location with the book directory of the `grails-app/views` directory. This is convenient, but you can use an absolute path instead of a relative one:

```
def show() {
  def map = [book: Book.get(params.id)]
  render(view: "/shared/display", model: map)
}
```

In this case Grails will attempt to render a view at the location `grails-app/views/shared/display.gsp`. Grails also supports JSPs as views, so if a GSP isn't found in the expected location but a JSP is, it will be used.

Selecting Views For Namespaced Controllers

If a controller defines a namespace for itself with the [namespace](#) property that will affect the root directory specified with a relative path. The default root directory for views rendered by a namespaced controller is `<controller namespace>/views/<controller name>/`. If the view is not found in the namespaced directory then Grails will look in the non-namespaced directory.

See the example below.

```
class ReportingController {
  static namespace = 'business'

  def humanResources() {
    // This will render grails-app/views/business/reporting/humanResources.gsp
    // if it exists.

    // If grails-app/views/business/reporting/humanResources.gsp does not
    // exist the fallback will be grails-app/views/reporting/humanResources.gsp.
    // The namespaced GSP will take precedence over the non-namespaced GSP.
    [numberOfEmployees: 9]
  }

  def accountsReceivable() {
    // This will render grails-app/views/business/reporting/accounting.gsp
    // if it exists.

    // If grails-app/views/business/reporting/accounting.gsp does not
    // exist the fallback will be grails-app/views/reporting/accounting.gsp.
    // The namespaced GSP will take precedence over the non-namespaced GSP.
    render view: 'numberCrunch', model: [numberOfEmployees: 13]
  }
}
```

Rendering a Response

Sometimes it's easier (for example with Ajax applications) to render snippets of text or code to the response. A highly flexible render method can be used:

```
render "Hello World!"
```

The above code writes the text "Hello World!" to the response. Other examples include:

```
// write some markup
render {
    for (b in books) {
        div(id: b.id, b.title)
    }
}
```

```
// render a specific view
render(view: 'show')
```

```
// render a template for each item in a collection
render(template: 'book_template', collection: Book.list())
```

```
// render some text with encoding and content type
render(text: "<xml>some xml</xml>", contentType: "text/xml", encoding: "UTF-8")
```

If you plan on using Groovy's MarkupBuilder to generate HTML for use with the render method elements and Grails tags, for example:

```

import groovy.xml.MarkupBuilder

...
def login() {
    def writer = new StringWriter()
    def builder = new MarkupBuilder(writer)
    builder.html {
        head {
            title 'Log in'
        }
        body {
            h1 'Hello'
            form {
            }
        }
    }
}

def html = writer.toString()
render html
}

```

This will actually [call the form tag](#) (which will return some text that will be ignored by the MarkupBuilder) use the following:

```

def login() {
    // ...
    body {
        h1 'Hello'
        builder.form {
        }
    }
    // ...
}

```

8.1.4 Redirects and Chaining

Redirects

Actions can be redirected using the [redirect](#) controller method:

```
class OverviewController {
  def login() {}
  def find() {
    if (!session.user)
      redirect(action: 'login')
    return
  }
  ...
}
```

Internally the [redirect](#) method uses the [HttpServletResponse](#) object's `sendRedirect` method.

The `redirect` method expects one of:

- Another closure within the same controller class:

```
// Call the login action within the same class
redirect(action: login)
```

- The name of an action (and controller name if the redirect isn't to an action in the current controller):

```
// Also redirects to the index action in the home controller
redirect(controller: 'home', action: 'index')
```

- A URI for a resource relative the application context path:

```
// Redirect to an explicit URI
redirect(uri: "/login.html")
```

- Or a full URL:

```
// Redirect to a URL
redirect(url: "http://grails.org")
```

Parameters can optionally be passed from one action to the next using the `params` argument of the method.

```
redirect(action: 'myaction', params: [myparam: "myvalue"])
```

These parameters are made available through the [params](#) dynamic property that accesses request parameters. If a request parameter with the same name as a controller parameter is present, the request parameter is overridden and the controller parameter is used.

Since the `params` object is a `Map`, you can use it to pass the current request parameters from one action to the next.

```
redirect(action: "next", params: params)
```

Finally, you can also include a fragment in the target URI:

```
redirect(controller: "test", action: "show", fragment: "profile")
```

which will (depending on the URL mappings) redirect to something like `/myapp/test/show#profile`.

Chaining

Actions can also be chained. Chaining allows the model to be retained from one action to the next. For example,

```
class ExampleChainController {
  def first() {
    chain(action: second, model: [one: 1])
  }
  def second () {
    chain(action: third, model: [two: 2])
  }
  def third() {
    [three: 3])
  }
}
```

results in the model:

```
[one: 1, two: 2, three: 3]
```

The model can be accessed in subsequent controller actions in the chain using the `chainModel` map following the call to the `chain` method:

```
class ChainController {
  def nextInChain() {
    def model = chainModel.myModel
    ...
  }
}
```

Like the `redirect` method you can also pass parameters to the `chain` method:

```
chain(action: "action1", model: [one: 1], params: [myparam: "param1"])
```

8.1.5 Data Binding

Data binding is the act of "binding" incoming request parameters onto the properties of an object or an entity with all necessary type conversion since request parameters, which are typically delivered by a form submitted by a user, may well not be.

Map Based Binding

The data binder is capable of converting and assigning values in a Map to properties of an object. The basics:

```
// grails-app/domain/Person.groovy
class Person {
    String firstName
    String lastName
    Integer age
}
```

```
def bindingMap = [firstName: 'Peter', lastName: 'Gabriel', age: 63]
def person = new Person(bindingMap)

assert person.firstName == 'Peter'
assert person.lastName == 'Gabriel'
assert person.age == 63
```

To update properties of a domain object you may assign a Map to the `properties` property of the domain object.

```
def bindingMap = [firstName: 'Peter', lastName: 'Gabriel', age: 63]

def person = Person.get(someId)
person.properties = bindingMap

assert person.firstName == 'Peter'
assert person.lastName == 'Gabriel'
assert person.age == 63
```

The binder can populate a full graph of objects using Maps of Maps.


```

class Person {
    String firstName
    String lastName
    Integer age
    Address homeAddress
}

class Address {
    String county
    String country
}

```

```

def bindingMap = [firstName: 'Peter', lastName: 'Gabriel', age: 63, homeAddress:
'England'] ]

def person = new Person(bindingMap)

assert person.firstName == 'Peter'
assert person.lastName == 'Gabriel'
assert person.age == 63
assert person.homeAddress.county == 'Surrey'
assert person.homeAddress.country == 'England'

```

Binding To Collections And Maps

The data binder can populate and update Collections and Maps. The following code shows a simple example class:

```

class Band {
    String name
    static hasMany = [albums: Album]
    List albums
}

class Album {
    String title
    Integer numberOfTracks
}

```

```
def bindingMap = [name: 'Genesis',
                  'albums[0]': [title: 'Foxtrot', numberOfTracks: 6],
                  'albums[1]': [title: 'Nursery Cryme', numberOfTracks: 7]]

def band = new Band(bindingMap)

assert band.name == 'Genesis'
assert band.albums.size() == 2
assert band.albums[0].title == 'Foxtrot'
assert band.albums[0].numberOfTracks == 6
assert band.albums[1].title == 'Nursery Cryme'
assert band.albums[1].numberOfTracks == 7
```

That code would work in the same way if albums were an array instead of a List.

Note that when binding to a Set the structure of the Map being bound to the Set is the same as that of a unordered, the indexes don't necessarily correspond to the order of elements in the Set. In the code example List, the bindingMap could look exactly the same but 'Foxtrot' might be the first album in the Set or elements in a Set the Map being assigned to the Set must have id elements in it which represent the following example:

```
/*
 * The value of the indexes 0 and 1 in albums[0] and albums[1] are arbitrary
 * values that can be anything as long as they are unique within the Map.
 * They do not correspond to the order of elements in albums because albums
 * is a Set.
 */
def bindingMap = ['albums[0]': [id: 9, title: 'The Lamb Lies Down On Broadway'],
                  'albums[1]': [id: 4, title: 'Selling England By The Pound']]

def band = Band.get(someBandId)

/*
 * This will find the Album in albums that has an id of 9 and will set its title
 * to 'The Lamb Lies Down On Broadway' and will find the Album in albums that has
 * an id of 4 and set its title to 'Selling England By The Pound'. In both
 * cases if the Album cannot be found in albums then the album will be retrieved
 * from the database by id, the Album will be added to albums and will be updated
 * with the values described above. If a Album with the specified id cannot be
 * found in the database, then a binding error will be created and associated
 * with the band object. More on binding errors later.
 */
band.properties = bindingMap
```

When binding to a Map the structure of the binding Map is the same as the structure of a Map used for binding. The square brackets corresponds to the key in the Map being bound to. See the following code:

```
class Album {
  String title
  static hasMany = [players: Player]
  Map players
}

class Player {
  String name
}
```

```
def bindingMap = [title: 'The Lamb Lies Down On Broadway',
                  'players[guitar]': [name: 'Steve Hackett'],
                  'players[vocals]': [name: 'Peter Gabriel'],
                  'players[keyboards]': [name: 'Tony Banks']]

def album = new Album(bindingMap)

assert album.title == 'The Lamb Lies Down On Broadway'
assert album.players.size() == 3
assert album.players.guitar.name == 'Steve Hackett'
assert album.players.vocals.name == 'Peter Gabriel'
assert album.players.keyboards.name == 'Tony Banks'
```

When updating an existing Map, if the key specified in the binding Map does not exist in the Map being added to the Map with the specified key as in the following example:

```

def bindingMap = [title: 'The Lamb Lies Down On Broadway',
                  'players[guitar]': [name: 'Steve Hackett'],
                  'players[vocals]': [name: 'Peter Gabriel'],
                  'players[keyboards]': [name: 'Tony Banks']]

def album = new Album(bindingMap)

assert album.title == 'The Lamb Lies Down On Broadway'
assert album.players.size() == 3
assert album.players.guitar == 'Steve Hackett'
assert album.players.vocals == 'Peter Gabriel'
assert album.players.keyboards == 'Tony Banks'

def updatedBindingMap = ['players[drums]': [name: 'Phil Collins'],
                        'players[keyboards]': [name: 'Anthony George Banks']]

album.properties = updatedBindingMap

assert album.title == 'The Lamb Lies Down On Broadway'
assert album.players.size() == 4
assert album.players.guitar.name == 'Steve Hackett'
assert album.players.vocals.name == 'Peter Gabriel'
assert album.players.keyboards.name == 'Anthony George Banks'
assert album.players.drums.name == 'Phil Collins'

```

Binding Request Data to the Model

The [params](#) object that is available in a controller has special behavior that helps convert dotted request parameters into a format that the `params` binder can work with. For example, if a request includes request parameters named `person.homeAddress.city` with values 'USA' and 'St. Louis' respectively, `params` would include

```
[person: [homeAddress: [country: 'USA', city: 'St. Louis']]]
```

There are two ways to bind request parameters onto the properties of a domain class. The first involves using

```

def save() {
  def b = new Book(params)
  b.save()
}

```

The data binding happens within the code `new Book(params)`. By passing the [params](#) object to the constructor, the `Book` class recognizes that you are trying to bind from request parameters. So if we had an incoming request like:

```
/book/save?title=The%20Stand&author=Stephen%20King
```

Then the `title` and `author` request parameters would automatically be set on the domain class. You binding onto an existing instance:

```
def save() {  
    def b = Book.get(params.id)  
    b.properties = params  
    b.save()  
}
```

This has the same effect as using the implicit constructor.

When binding an empty String (a String with no characters in it, not even spaces), the data binder will con most common case where the intent is to treat an empty form field as having the value null since there is parameter. When this behavior is not desirable the application may assign the value directly.

The mass property binding mechanism will by default automatically trim all Strings at binding. To disable this, set the `grails.databinding.trimStrings` property to false in `grails-app/conf/application.`

```
// the default value is true  
grails.databinding.trimStrings = false  
  
// ...
```

The mass property binding mechanism will by default automatically convert all empty Strings to null at binding. To disable this, set the `grails.databinding.convertEmptyStringsToNull` property to false in `grails-app/conf/application.`

```
// the default value is true  
grails.databinding.convertEmptyStringsToNull = false  
  
// ...
```

The order of events is that the String trimming happens and then null conversion happens. If `convertEmptyStringsToNull` is `true`, not only will empty Strings be converted to null but also that the `trim()` method returns an empty String.



These forms of data binding in Grails are very convenient, but also indiscriminate. In other words, if a non-transient, typed instance property of the target object, including ones that you may not expect in your UI doesn't submit all the properties, an attacker can still send malicious data. Fortunately, Grails also makes it easy to protect against such attacks - see the section titled "Security Concerns" for more information.

Data binding and Single-ended Associations

If you have a one-to-one or many-to-one association you can use Grails' data binding capability to handle an incoming request such as:

```
/book/save?author.id=20
```

Grails will automatically detect the `.id` suffix on the request parameter and look up the `Author` instance as:

```
def b = new Book(params)
```

An association property can be set to null by passing the literal String `"null"`. For example:

```
/book/save?author.id=null
```

Data Binding and Many-ended Associations

If you have a one-to-many or many-to-many association there are different techniques for data binding depending on the association type.

If you have a Set based association (the default for a `hasMany`) then the simplest way to populate an association is by using the `<g:select>` tag. For example consider the usage of `<g:select>` below:

```
<g:select name="books"
  from="${Book.list()}"
  size="5" multiple="yes" optionKey="id"
  value="${author?.books}" />
```

This produces a select box that lets you select multiple values. In this case if you submit the form Grails select box to populate the `books` association.

However, if you have a scenario where you want to update the properties of the associated objects the subscript operator:

```
<g:textField name="books[0].title" value="the Stand" />
<g:textField name="books[1].title" value="the Shining" />
```

However, with `Set` based association it is critical that you render the mark-up in the same order that you has no concept of order, so although we're referring to `books0` and `books1` it is not guaranteed that the server side unless you apply some explicit sorting yourself.

This is not a problem if you use `List` based associations, since a `List` has a defined order and an index associations.

Note also that if the association you are binding to has a size of two and you refer to an element that is out of

```
<g:textField name="books[0].title" value="the Stand" />
<g:textField name="books[1].title" value="the Shining" />
<g:textField name="books[2].title" value="Red Madder" />
```

Then Grails will automatically create a new instance for you at the defined position.

You can bind existing instances of the associated type to a `List` using the same `.id` syntax as you've seen in the example:

```

<g:select name="books[0].id" from="${bookList}"
          value="${author?.books[0]?.id}" />
<g:select name="books[1].id" from="${bookList}"
          value="${author?.books[1]?.id}" />
<g:select name="books[2].id" from="${bookList}"
          value="${author?.books[2]?.id}" />

```

Would allow individual entries in the `books List` to be selected separately.

Entries at particular indexes can be removed in the same way too. For example:

```

<g:select name="books[0].id"
          from="${Book.list()}"
          value="${author?.books[0]?.id}"
          noSelection="['null': '']"/>

```

Will render a select box that will remove the association at `books0` if the empty option is chosen.

Binding to a Map property works the same way except that the list index in the parameter name is replaced

```

<g:select name="images[cover].id"
          from="${Image.list()}"
          value="${book?.images[cover]?.id}"
          noSelection="['null': '']"/>

```

This would bind the selected image into the Map property `images` under a key of `"cover"`.

When binding to Maps, Arrays and Collections the data binder will automatically grow the size of the collection



The default limit to how large the binder will grow a collection is 256. If the data binder encounters the collection be grown beyond that limit, the entry is ignored. The limit may be configured with the `grails.databinding.autoGrowCollectionLimit` property in `application.groovy`.


```
// grails-app/conf/application.groovy
// the default value is 256
grails.databinding.autoGrowCollectionLimit = 128
// ...
```

Data binding with Multiple domain classes

It is possible to bind data to multiple domain objects from the [params](#) object.

For example so you have an incoming request to:

```
/book/save?book.title=The%20Stand&author.name=Stephen%20King
```

You'll notice the difference with the above request is that each parameter has a prefix such as `author.name` to indicate which type. Grails' `params` object is like a multi-dimensional hash and you can use it to bind parameters to bind.

```
def b = new Book(params.book)
```

Notice how we use the prefix before the first dot of the `book.title` parameter to isolate only parameters that belong to an `Author` domain class:

```
def a = new Author(params.author)
```

Data Binding and Action Arguments

Controller action arguments are subject to request parameter data binding. There are 2 categories of command objects. Complex types are treated as command objects. See the [Command Objects](#) section of basic object types. Supported types are the 8 primitives, their corresponding type wrappers and [java.lang](#) parameters to action arguments by name:

```
class AccountingController {  
  // accountNumber will be initialized with the value of params.accountNumber  
  // accountType will be initialized with params.accountType  
  def displayInvoice(String accountNumber, int accountType) {  
    // ...  
  }  
}
```

For primitive arguments and arguments which are instances of any of the primitive type wrapper classes a request parameter value can be bound to the action argument. The type conversion happens automatically. `params.accountType` request parameter has to be converted to an `int`. If type conversion fails for value per normal Java behavior (null for type wrapper references, false for booleans and zero for numbers), errors property of the defining controller.

```
/accounting/displayInvoice?accountNumber=B59786&accountType=bogusValue
```

Since "bogusValue" cannot be converted to type `int`, the value of `accountType` will be zero, the controller's `errors.errorCount` will be equal to 1 and the controller's `errors.getFieldErrors` corresponding error.

If the argument name does not match the name of the request parameter then the `@grails.web.RequestParameter` annotation can be used to express the name of the request parameter which should be bound to that argument:

```
import grails.web.RequestParameter  
  
class AccountingController {  
  // mainAccountNumber will be initialized with the value of params.accountNumber  
  // accountType will be initialized with params.accountType  
  def displayInvoice(@RequestParameter('accountNumber') String mainAccountNumber, int accountType) {  
    // ...  
  }  
}
```

Data binding and type conversion errors

Sometimes when performing data binding it is not possible to convert a particular String into a particular error. Grails will retain type conversion errors inside the [errors](#) property of a Grails domain class. For example:

```
class Book {  
    ...  
    URL publisherURL  
}
```

Here we have a domain class `Book` that uses the `java.net.URL` class to represent URLs. Given an incorrect URL:

```
/book/save?publisherURL=a-bad-url
```

it is not possible to bind the string `a-bad-url` to the `publisherURL` property as a type mismatch error:

```
def b = new Book(params)  
if (b.hasErrors()) {  
    println "The value ${b.errors.getFieldError('publisherURL').rejectedValue} " +  
           " is not a valid URL!"  
}
```

Although we have not yet covered error codes (for more information see the section on [Validation](#)), for type mismatch errors you can refer to the `grails-app/i18n/messages.properties` file to use for the error. You can use a generic error:

```
typeMismatch.java.net.URL=The field {0} is not a valid URL
```

Or a more specific one:

```
typeMismatch.Book.publisherURL=The publisher URL you specified is not a valid URL
```

The BindUsing Annotation

The [BindUsing](#) annotation may be used to define a custom binding mechanism for a particular field in a class. When the field is bound, the closure value of the annotation will be invoked with 2 arguments. The first argument is the object being bound to the field, and the second argument is [DataBindingSource](#) which is the data source for the data binding. The value returned from the closure will be used to set the value of the field. The following example would result in the upper case version of the name value in the source being applied to the field.

```
import org.grails.databinding.BindUsing

class SomeClass {
    @BindUsing({obj, source ->
        //source is DataSourceBinding which is similar to a Map
        //and defines getAt operation but source.name cannot be used here.
        //In order to get name from source use getAt instead as shown below.
        source['name']?.toUpperCase()
    })
    String name
}
```



Note that data binding is only possible when the name of the request parameter matches with the name of the field. Here, name from request parameters matches with name from SomeClass.

The [BindUsing](#) annotation may be used to define a custom binding mechanism for all of the fields on a particular class. The value assigned to the annotation should be a class which implements the [BindingHelper](#) interface. This class will be invoked every time a value is bound to a property in the class that this annotation has been applied to.

```
@BindUsing(SomeClassWhichImplementsBindingHelper)
class SomeClass {
    String someProperty
    Integer someOtherProperty
}
```

Custom Data Converters

The binder will do a lot of type conversion automatically. Some applications may want to define their own way to do this is to write a class which implements [ValueConverter](#) and register an instance of that class as

```
package com.myapp.converters

import org.grails.databinding.converters.ValueConverter

/**
 * A custom converter which will convert String of the
 * form 'city:state' into an Address object.
 */
class AddressValueConverter implements ValueConverter {

    boolean canConvert(value) {
        value instanceof String
    }

    def convert(value) {
        def pieces = value.split(':')
        new com.myapp.Address(city: pieces[0], state: pieces[1])
    }

    Class<?> getTargetType() {
        com.myapp.Address
    }
}
```

An instance of that class needs to be registered as a bean in the Spring application context. The bean named `ValueConverter` will be automatically plugged in to the data binding process.

```
// grails-app/conf/spring/resources.groovy

beans = {
    addressConverter com.myapp.converters.AddressValueConverter
    // ...
}
```

```

class Person {
    String firstName
    Address homeAddress
}

class Address {
    String city
    String state
}

def person = new Person()
person.properties = [firstName: 'Jeff', homeAddress: "O'Fallon:Missouri"]
assert person.firstName == 'Jeff'
assert person.homeAddress.city = "O'Fallon"
assert person.homeAddress.state = 'Missouri'

```

Date Formats For Data Binding

A custom date format may be specified to be used when binding a String to a Date value by applying the [@BindingFormat](#) annotation.

```

import org.grails.databinding.BindingFormat

class Person {
    @BindingFormat('MMddyyyy')
    Date birthDate
}

```

A global setting may be configured in `application.groovy` to define date formats which will be used by default.

```

// grails-app/conf/application.groovy
grails.databinding.dateFormats = ['MMddyyyy', 'yyyy-MM-dd HH:mm:ss.S', "yyyy-MM-dd'T'HH:mm:ss'Z'"]

```

The formats specified in `grails.databinding.dateFormats` will be attempted in the order in which they are specified. If a format is successful, the value is converted. If not, the next format is attempted. If marked with `@BindingFormat`, the `@BindingFormat` will take precedence over the values specified in `grails.databinding.dateFormats`.

The default formats that are used are "yyyy-MM-dd HH:mm:ss.S", "yyyy-MM-dd'T'hh:mm:ss'Z'" and "yyyy-MM-dd'T'hh:mm:ss'Z'".

Custom Formatted Converters

You may supply your own handler for the [BindingFormat](#) annotation by writing a class which implements registering an instance of that class as a bean in the Spring application context. Below is an example of a `BindingFormat` annotation for the case of a String based on the value assigned to the `BindingFormat` annotation.

```
package com.myapp.converters

import org.grails.databinding.converters.FormattedValueConverter

class FormattedStringValueConverter implements FormattedValueConverter {
    def convert(value, String format) {
        if('UPPERCASE' == format) {
            value = value.toUpperCase()
        } else if('LOWERCASE' == format) {
            value = value.toLowerCase()
        }
        value
    }
}

Class targetType() {
    // specifies the type to which this converter may be applied
    String
}
}
```

An instance of that class needs to be registered as a bean in the Spring application context. The bean named `FormattedValueConverter` will be automatically plugged in to the data binding process.

```
// grails-app/conf/spring/resources.groovy

beans = {
    formattedStringValueConverter com.myapp.converters.FormattedStringValueConverter
    // ...
}
```

With that in place the `BindingFormat` annotation may be applied to String fields to inform the data binding process.

```
import org.grails.databinding.BindingFormat

class Person {
    @BindingFormat('UPPERCASE')
    String someUpperCaseString

    @BindingFormat('LOWERCASE')
    String someLowerCaseString

    String someOtherString
}
```

Localized Binding Formats

The `BindingFormat` annotation supports localized format strings by using the optional `code` attribute value will be used as the message code to retrieve the binding format string from the `messageSource` lookup will be localized.

```
import org.grails.databinding.BindingFormat

class Person {
    @BindingFormat(code='date.formats.birthdays')
    Date birthDate
}
```

```
# grails-app/conf/i18n/messages.properties
date.formats.birthdays=MMddyyyy
```

```
# grails-app/conf/i18n/messages_es.properties
date.formats.birthdays=ddMMyyyy
```

Structured Data Binding Editors

A structured data binding editor is a helper class which can bind structured request parameters to a proper is binding to a Date object which might be constructed from several smaller pieces of information cont like birthday_month, birthday_date and birthday_year. The structured editor would retriee and use them to construct a Date.

The framework provides a structured editor for binding to Date objects. An application may register it appropriate. Consider the following classes:

```
// src/groovy/databinding/Gadget.groovy
package databinding

class Gadget {
    Shape expandedShape
    Shape compressedShape
}
```

```
// src/groovy/databinding/Shape.groovy
package databinding

class Shape {
    int area
}
```

A Gadget has 2 Shape fields. A Shape has an area property. It may be that the application wants height and use those to calculate the area of a Shape at binding time. A structured binding editor is w

The way to register a structured editor with the data binding process is to add an instance of the [org.grails.databinding.converters.AbstractStructuredBindingEditor](#) interface to the Spring application context. The easiest way to implement the TypedStructured: [org.grails.databinding.converters.AbstractStructuredBindingEditor](#) abstract class and override the getProc

```
// src/groovy/databinding/converters/StructuredShapeEditor.groovy
package databinding.converters

import databinding.Shape
import org.grails.databinding.converters.AbstractStructuredBindingEditor

class StructuredShapeEditor extends AbstractStructuredBindingEditor<Shape> {

public Shape getPropertyValue(Map values) {
    // retrieve the individual values from the Map
    def width = values.width as int
    def height = values.height as int

    // use the values to calculate the area of the Shape
    def area = width * height

    // create and return a Shape with the appropriate area
    new Shape(area: area)
}
}
```

An instance of that class needs to be registered with the Spring application context:

```
// grails-app/conf/spring/resources.groovy
beans = {
    shapeEditor databinding.converters.StructuredShapeEditor

    // ...
}
```

When the data binder binds to an instance of the `Gadget` class it will check to see if there are request parameters `expandedShape` which have a value of "struct" and if they do exist, that will trigger the use of the components of the structure need to have parameter names of the form `propertyName_structuredElement` that would mean that the `compressedShape` request parameter should have a value of "struct" `compressedShape_height` parameters should have values which represent the width and the height `expandedShape` request parameter should have a value of "struct" and the `expandedShape_width` should have values which represent the width and the height of the expanded Shape.

```
// grails-app/controllers/demo/DemoController.groovy
class DemoController {
    def createGadget(Gadget gadget) {
        /*
        /demo/createGadget?expandedShape=struct&expandedShape_width=80&expandedShape_heig
        &compressedShape=struct&compressedShape_width=10&compre

        */
        // with the request parameters shown above gadget.expandedShape.area would be 240
        // and gadget.compressedShape.area would be 30

        // ...
    }
}
```

Typically the request parameters with "struct" as their value would be represented by hidden form fields.

Data Binding Event Listeners

The [DataBindingListener](#) interface provides a mechanism for listeners to be notified of data binding events

```

package org.grails.databinding.events;

import org.grails.databinding.errors.BindingError;

public interface DataBindingListener {

    /**
     * @return true if the listener is interested in events for the specified type
     */
    boolean supports(Class<?> clazz);

    /**
     * Called when data binding is about to start.
     *
     * @param target The object data binding is being imposed upon
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     * @return true if data binding should continue
     */
    Boolean beforeBinding(Object target, Object errors);

    /**
     * Called when data binding is about to be imposed on a property
     *
     * @param target The object data binding is being imposed upon
     * @param propertyName The name of the property being bound to
     * @param value The value of the property being bound
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     * @return true if data binding should continue, otherwise return false
     */
    Boolean beforeBinding(Object target, String propertyName, Object value, Object errors);

    /**
     * Called after data binding has been imposed on a property
     *
     * @param target The object data binding is being imposed upon
     * @param propertyName The name of the property that was bound to
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     */
    void afterBinding(Object target, String propertyName, Object errors);

    /**
     * Called after data binding has finished.
     *
     * @param target The object data binding is being imposed upon
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     */
    void afterBinding(Object target, Object errors);

    /**
     * Called when an error occurs binding to a property
     * @param error encapsulates information about the binding error
     * @param errors the Spring Errors instance (a org.springframework.validation.Errors)
     * @see BindingError
     */
    void bindingError(BindingError error, Object errors);
}

```

Any bean in the Spring application context which implements that interface will automatically be picked up. The [DataBindingListenerAdapter](#) class implements the `DataBindingListener` interface and provides a default implementation of the interface so this class is well suited for subclassing so your listener class only needs to provide the methods you are interested in.

The Grails data binder has limited support for the older [BindEventListener](#) style listeners. `BindEventListener`

```

package org.codehaus.groovy.grails.web.binding;

import org.springframework.beans.MutablePropertyValues;
import org.springframework.beans.TypeConverter;

public interface BindEventListener {

    /**
     * @param target The target to bind to
     * @param source The source of the binding, typically a Map
     * @param typeConverter The type converter to be used
     */
    void doBind(Object target, MutablePropertyValues source, TypeConverter typeCo
}

```

Support for `BindEventListener` is disabled by default. To enable support `grails.databinding.enableSpringEventAdapter` property in `grails-app/conf/application.groovy`

```

// grails-app/conf/application.groovy
grails.databinding.enableSpringEventAdapter=true

...

```

With `enableSpringEventAdapter` set to `true` instances of `BindEventListener` which automatically be registered with the data binder. Notice that the `MutablePropertyValues` and `doBind` method in `BindEventListener` are Spring specific classes and are not relevant to the current data binder for those arguments. The only real value passed into the `doBind` method will be the object being bound to the data binder and will be useful for a subset of scenarios. Developers are encouraged to migrate their `DataBindingListener` model.

Using The Data Binder Directly

There are situations where an application may want to use the data binder directly. For example, to do binding on a domain class. The following will not work because the `properties` property is read only.

```

// src/groovy/bindingdemo/Widget.groovy
package bindingdemo

class Widget {
    String name
    Integer size
}

```

```
// grails-app/services/bindingdemo/WidgetService.groovy
package bindingdemo

class WidgetService {
    def updateWidget(Widget widget, Map data) {
        // this will throw an exception because
        // properties is read-only
        widget.properties = data
    }
}
```

An instance of the data binder is in the Spring application context with a bean name of `grailsWebDataBinder`. The following code demonstrates using the data binder directly.

```
// grails-app/services/bindingdemo/WidgetService
package bindingdemo

import org.grails.databinding.SimpleMapDataBindingSource

class WidgetService {
    // this bean will be autowired into the service
    def grailsWebDataBinder

    def updateWidget(Widget widget, Map data) {
        grailsWebDataBinder.bind widget, data as SimpleMapDataBindingSource
    }
}
```

See the [DataBinder](#) documentation for more information about overloaded versions of the `bind` method.

Data Binding and Security Concerns

When batch updating properties from request parameters you need to be careful not to allow clients to persist data in the database. You can limit what properties are bound to a given domain class using the `subscribed` method.

```
def p = Person.get(1)
p.properties['firstName','lastName'] = params
```

In this case only the `firstName` and `lastName` properties will be bound.

Another way to do this is to use [Command Objects](#) as the target of data binding instead of domain objects. The `bindData` method.

The `bindData` method allows the same data binding capability, but to arbitrary objects:

```
def p = new Person()  
bindData(p, params)
```

The `bindData` method also lets you exclude certain parameters that you don't want updated:

```
def p = new Person()  
bindData(p, params, [exclude: 'dateOfBirth'])
```

Or include only certain properties:

```
def p = new Person()  
bindData(p, params, [include: ['firstName', 'lastName']])
```



Note that if an empty List is provided as a value for the `include` parameter then all fields are included. If a non-empty List is provided, only the fields in the List are included; all other fields are not explicitly excluded.

The [bindable](#) constraint can be used to globally prevent data binding for certain properties.

8.1.6 XML and JSON Responses

Using the render method to output XML

Grails supports a few different ways to produce XML and JSON responses. The first is the [render](#) method.

The `render` method can be passed a block of code to do mark-up building in XML:

```
def list() {
def results = Book.list()
render(contentType: "text/xml") {
    books {
        for (b in results) {
            book(title: b.title)
        }
    }
}
}
```

The result of this code would be something like:

```
<books>
  <book title="The Stand" />
  <book title="The Shining" />
</books>
```

Be careful to avoid naming conflicts when using mark-up building. For example this code would produce a

```
def list() {
def books = Book.list() // naming conflict here
render(contentType: "text/xml") {
    books {
        for (b in results) {
            book(title: b.title)
        }
    }
}
}
```

This is because there is local variable `books` which Groovy attempts to invoke as a method.

Using the render method to output JSON

The render method can also be used to output JSON:


```
def list() {
def results = Book.list()
render(contentType: "application/json") {
    books = array {
        for (b in results) {
            book title: b.title
        }
    }
}
```

In this case the result would be something along the lines of:

```
[
  { "title": "The Stand" },
  { "title": "The Shining" }
]
```

The same dangers with naming conflicts described above for XML also apply to JSON building.

Automatic XML Marshalling

Grails also supports automatic marshalling of [domain classes](#) to XML using special converters.

To start off with, import the `grails.converters` package into your controller:

```
import grails.converters.*
```

Now you can use the following highly readable syntax to automatically convert domain classes to XML:

```
render Book.list() as XML
```

The resulting output would look something like the following::

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<list>
  <book id="1">
    <author>Stephen King</author>
    <title>The Stand</title>
  </book>
  <book id="2">
    <author>Stephen King</author>
    <title>The Shining</title>
  </book>
</list>
```

For more information on XML marshalling see the section on [REST](#)

Automatic JSON Marshalling

Grails also supports automatic marshalling to JSON using the same mechanism. Simply substitute XML with

```
render Book.list() as JSON
```

The resulting output would look something like the following:

```
[
  {
    "id":1,
    "class":"Book",
    "author":"Stephen King",
    "title":"The Stand"},
  {
    "id":2,
    "class":"Book",
    "author":"Stephen King",
    "releaseDate":new Date(1194127343161),
    "title":"The Shining"}
]
```

8.1.7 More on JSONBuilder

The previous section on XML and JSON responses covered simplistic examples of rendering XML and by Grails is the standard [XmlSlurper](#) found in Groovy, the JSON builder is a custom implementation speci

JSONBuilder and Grails versions

JSONBuilder behaves different depending on the version of Grails you use. For version below 1.2 the de
This section covers the usage of the Grails 1.2 JSONBuilder

For backwards compatibility the old JSONBuilder class is used with the render method for
JSONBuilder class set the following in application.groovy:

```
grails.json.legacy.builder = false
```

Rendering Simple Objects

To render a simple JSON object just set properties within the context of the Closure:

```
render(contentType: "application/json") {  
    hello = "world"  
}
```

The above will produce the JSON:

```
{ "hello": "world" }
```

Rendering JSON Arrays

To render a list of objects simple assign a list:

```
render(contentType: "application/json") {  
    categories = ['a', 'b', 'c']  
}
```

This will produce:

```
{ "categories": [ "a", "b", "c" ] }
```

You can also render lists of complex objects, for example:

```
render(contentType: "application/json") {  
  categories = [ { a = "A" }, { b = "B" } ]  
}
```

This will produce:

```
{ "categories": [ { "a": "A" } , { "b": "B" } ] }
```

Use the special `element` method to return a list as the root:

```
render(contentType: "application/json") {  
  element 1  
  element 2  
  element 3  
}
```

The above code produces:

```
[ 1, 2, 3 ]
```

Rendering Complex Objects

Rendering complex objects can be done with Closures. For example:

```
render(contentType: "application/json") {  
    categories = ['a', 'b', 'c']  
    title = "Hello JSON"  
    information = {  
        pages = 10  
    }  
}
```

The above will produce the JSON:

```
{"categories":["a","b","c"],"title":"Hello JSON","information":{"pages":10}}
```

Arrays of Complex Objects

As mentioned previously you can nest complex objects within arrays using Closures:

```
render(contentType: "application/json") {  
    categories = [ { a = "A" }, { b = "B" } ]  
}
```

You can use the array method to build them up dynamically:

```
def results = Book.list()  
render(contentType: "application/json") {  
    books = array {  
        for (b in results) {  
            book title: b.title  
        }  
    }  
}
```

Direct JSONBuilder API Access

If you don't have access to the render method, but still want to produce JSON you can use the API direct

```
def builder = new JSONBuilder()

def result = builder.build {
  categories = ['a', 'b', 'c']
  title = "Hello JSON"
  information = {
    pages = 10
  }
}

// prints the JSON text
println result.toString()

def sw = new StringWriter()
result.render sw
```

8.1.8 Uploading Files

Programmatic File Uploads

Grails supports file uploads using Spring's [MultipartHttpServletRequest](#) interface. The first step for file up

```
Upload Form: <br />
<g:uploadForm action="upload">
  <input type="file" name="myFile" />
  <input type="submit" />
</g:uploadForm>
```

The uploadForm tag conveniently adds the enctype="multipart/form-data" attribute to the s

There are then a number of ways to handle the file upload. One is to work with the Spring [MultipartFile](#) in

```
def upload() {
  def f = request.getFile('myFile')
  if (f.empty) {
    flash.message = 'file cannot be empty'
    render(view: 'uploadForm')
    return
  }
  f.transferTo(new File('/some/local/dir/myfile.txt'))
  response.sendError(200, 'Done')
}
```

This is convenient for doing transfers to other destinations and manipulating the file directly as you can [MultipartFile](#) interface.

File Uploads through Data Binding

File uploads can also be performed using data binding. Consider this Image domain class:

```
class Image {
    byte[] myFile
    static constraints = {
        // Limit upload file size to 2MB
        myFile maxSize: 1024 * 1024 * 2
    }
}
```

If you create an image using the params object in the constructor as in the example below, Grails will aut the myFile property:

```
def img = new Image(params)
```

It's important that you set the [size](#) or [maxSize](#) constraints, otherwise your database may be created with a sized files. For example, both H2 and MySQL default to a blob size of 255 bytes for byte properties.

It is also possible to set the contents of the file as a string by changing the type of the myFile property on

```
class Image {
    String myFile
}
```

8.1.9 Command Objects

Grails controllers support the concept of command objects. A command object is a class that is used in validation of data that may not fit into an existing domain class.



Note: A class is only considered to be a command object when it is used as a parameter of an

Declaring Command Objects

Command object classes are defined just like any other class.

```
class LoginCommand implements grails.validation.Validateable {
    String username
    String password

    static constraints = {
        username(blank: false, minSize: 6)
        password(blank: false, minSize: 6)
    }
}
```

In this example, the command object class implements the `Validateable` trait. The `Validateable` is in [domain classes](#). If the command object is defined in the same source file as the controller that it implements, it is not required that command object classes be `validateable`. It is not required that command object classes be `validateable`.

By default, all `Validateable` object properties are `nullable: false` which matches the behavior of `Validateable` that has `nullable: true` properties by default, you can specify this by defining a `defaultNullable()` method.

```
class AuthorSearchCommand implements grails.validation.Validateable {
    String name
    Integer age

    static boolean defaultNullable() {
        true
    }
}
```

In this example, both `name` and `age` will allow null values during validation.

Using Command Objects

To use command objects, controller actions may optionally specify any number of command object parameters that Grails knows what objects to create and initialize.

Before the controller action is executed Grails will automatically create an instance of the command object with the request parameters. If the command object class is marked with `Validateable` then the command object will be validated.


```

class LoginController {
def login(LoginCommand cmd) {
    if (cmd.hasErrors()) {
        redirect(action: 'loginForm')
        return
    }

    // work with the command object data
}
}

```

If the command object's type is that of a domain class and there is an `id` request parameter then instead of a new instance a call will be made to the static `get` method on the domain class and the value of the Whatever is returned from that call to `get` is what will be passed into the controller action. This means corresponding record is found in the database then the value of the command object will be `null`. If a database then `null` will be passed as an argument to the controller action and an error will be added the object's type is a domain class and there is no `id` request parameter or there is an `id` request parameter a into the controller action unless the HTTP request method is "POST", in which case a new instance of the domain class constructor. For all of the cases where the domain class instance is non-null, data binding is "POST", "PUT" or "PATCH".

Command Objects And Request Parameter Names

Normally request parameter names will be mapped directly to property names in the command object. Next the object graph in an intuitive way. In the example below a request parameter named `name` will be bound and a request parameter named `address.city` will be bound to the `city` property of the `address` property.

```

class StoreController {
    def buy(Person buyer) {
        // ...
    }
}

class Person {
    String name
    Address address
}

class Address {
    String city
}

```

A problem may arise if a controller action accepts multiple command objects which happen to contain the same example.

```

class StoreController {
    def buy(Person buyer, Product product) {
        // ...
    }
}

class Person {
    String name
    Address address
}

class Address {
    String city
}

class Product {
    String name
}

```

If there is a request parameter named `name` it isn't clear if that should represent the name of the `Product` of the problem can come up if a controller action accepts 2 command objects of the same type as shown below:

```

class StoreController {
    def buy(Person buyer, Person seller, Product product) {
        // ...
    }
}

class Person {
    String name
    Address address
}

class Address {
    String city
}

class Product {
    String name
}

```

To help deal with this the framework imposes special rules for mapping parameter names to command objects. It will treat all parameters that begin with the controller action parameter name as belonging to the corresponding command object. For example, the `product.name` request parameter will be bound to the `name` property in the `product` argument, the `buyer.name` request parameter will be bound to the `name` property in the `buyer` argument, the `seller.address.city` request parameter will be bound to the `city` property of the `seller` argument, etc...

Command Objects and Dependency Injection

Command objects can participate in dependency injection. This is useful if your command object has some [service](#):

```

class LoginCommand implements grails.validation.Validateable {
def loginService

String username
String password

static constraints = {
    username validator: { val, obj ->
        obj.loginService.canLogin(obj.username, obj.password)
    }
}
}

```

In this example the command object interacts with the loginService bean which is injected by name from the application context.

Binding The Request Body To Command Objects

When a request is made to a controller action which accepts a command object and the request contains a body, Grails will automatically bind the request body to the command object based on the request content type and use the body to do data binding on the command object.

```

// grails-app/controllers/bindingdemo/DemoController.groovy
package bindingdemo

class DemoController {
def createWidget(Widget w) {
    render "Name: ${w?.name}, Size: ${w?.size}"
}
}

class Widget {
String name
Integer size
}

```

```

$ curl -H "Content-Type: application/json" -d '{"name":"Some Widget","size":42}'
Name: Some Widget, Size: 42
~ $
$ curl -H "Content-Type: application/xml" -d '<widget><name>Some Other Widget</name><size>2112</size>'
localhost:8080/bodybind/demo/createWidget
Name: Some Other Widget, Size: 2112
~ $

```

Note that the body of the request is being parsed to make that work. Any attempt to read the body of the request input stream will be empty. The controller action can either use a command object or it can parse the body referring to something like `request.JSON`), but cannot do both.

```
// grails-app/controllers/bindingdemo/DemoController.groovy
package bindingdemo

class DemoController {
    def createWidget(Widget w) {
        // this will fail because it requires reading the body,
        // which has already been read.
        def json = request.JSON

        // ...
    }
}
```

8.1.10 Handling Duplicate Form Submissions

Grails has built-in support for handling duplicate form submissions using the "Synchronizer Token Pattern" tag:

```
<g:form useToken="true" ...>
```

Then in your controller code you can use the [withForm](#) method to handle valid and invalid requests:

```
withForm {
    // good request
}.invalidToken {
    // bad request
}
```

If you only provide the [withForm](#) method and not the chained `invalidToken` method then by default the `flash.invalidToken` variable and redirect the request back to the original page. This can then be checked

```
<g:if test="${flash.invalidToken}">
  Don't click the button twice!
</g:if>
```



The [withForm](#) tag makes use of the [session](#) and hence requires session affinity or clustered sessions.

8.1.11 Simple Type Converters

Type Conversion Methods

If you prefer to avoid the overhead of [Data Binding](#) and simply want to convert incoming parameters (the [params](#) object has a number of convenience methods for each type:

```
def total = params.int('total')
```

The above example uses the `int` method, and there are also methods for `boolean`, `long`, `char`, `short`, and `safe` from any parsing errors, so you don't have to perform any additional checks on the parameters.

Each of the conversion methods allows a default value to be passed as an optional second argument. The conversion entry cannot be found in the map or if an error occurs during the conversion. Example:

```
def total = params.int('total', 42)
```

These same type conversion methods are also available on the `attrs` parameter of GSP tags.

Handling Multi Parameters

A common use case is dealing with multiple request parameters of the same name. For example, `?name=Bob&name=Judy`.

In this case dealing with one parameter and dealing with many has different semantics since Groovy's `iterator` character. To avoid this problem the [params](#) object provides a `list` method that always returns a list:

```
for (name in params.list('name')) {  
    println name  
}
```

8.1.12 Declarative Controller Exception Handling

Grails controllers support a simple mechanism for declarative exception handling. If a controller declares argument type is `java.lang.Exception` or some subclass of `java.lang.Exception`, that method controller throws an exception of that type. See the following example.

```
// grails-app/controllers/demo/DemoController.groovy  
package demo  
  
class DemoController {  
    def someAction() {  
        // do some work  
    }  
  
    def handleSQLException(SQLException e) {  
        render 'A SQLException Was Handled'  
    }  
  
    def handleBatchUpdateException(BatchUpdateException e) {  
        redirect controller: 'logging', action: 'batchProblem'  
    }  
  
    def handleNumberFormatException(NumberFormatException nfe) {  
        [problemDescription: 'A Number Was Invalid']  
    }  
}
```

That controller will behave as if it were written something like this...

```
// grails-app/controllers/demo/DemoController.groovy
package demo

class DemoController {

def someAction() {
    try {
        // do some work
    } catch (BatchUpdateException e) {
        return handleBatchUpdateException(e)
    } catch (SQLException e) {
        return handleSQLException(e)
    } catch (NumberFormatException e) {
        return handleNumberFormatException(e)
    }
}

def handleSQLException(SQLException e) {
    render 'A SQLException Was Handled'
}

def handleBatchUpdateException(BatchUpdateException e) {
    redirect controller: 'logging', action: 'batchProblem'
}

def handleNumberFormatException(NumberFormatException nfe) {
    [problemDescription: 'A Number Was Invalid']
}
}
```

The exception handler method names can be any valid method name. The name is not what makes the method an exception handler; the argument type is the important part.

The exception handler methods can do anything that a controller action can do including invoking render.

One way to share exception handler methods across multiple controllers is to use inheritance. Exception handlers in an application could define the exception handlers in an abstract class that multiple controllers extend. Another way to share methods across multiple controllers is to use a trait, as shown below...

```
// src/groovy/com/demo/DatabaseExceptionHandler.groovy
package com.demo

trait DatabaseExceptionHandler {
    def handleSQLException(SQLException e) {
        // handle SQLException
    }

    def handleBatchUpdateException(BatchUpdateException e) {
        // handle BatchUpdateException
    }
}
```

```
// grails-app/controllers/com/demo/DemoController.groovy
package com.demo

class DemoController implements DatabaseExceptionHandler {
    // all of the exception handler methods defined
    // in DatabaseExceptionHandler will be added to
    // this class at compile time
}
```

Exception handler methods must be present at compile time. Specifically, exception handler method controller class are not supported.


8.2 Groovy Server Pages

Groovy Servers Pages (or GSP for short) is Grails' view technology. It is designed to be familiar for users far more flexible and intuitive.

GSPs live in the `grails-app/views` directory and are typically rendered automatically (by convention

```
render(view: "index")
```

A GSP is typically a mix of mark-up and GSP tags which aid in view rendering.

 Although it is possible to have Groovy logic embedded in your GSP and doing this will be possible, this practice is strongly discouraged. Mixing mark-up and code is a **bad** thing and most GSP pages do so.

A GSP typically has a "model" which is a set of variables that are used for view rendering. The model is an example consider the following controller action:

```
def show() {
    [book: Book.get(params.id)]
}
```

This action will look up a `Book` instance and create a model that contains a key called `book`. This key contains the name `book`:


```
${book.title}
```



Embedding data received from user input has the risk of making your application vulnerable to a Cross-Site Scripting (XSS) attack. Please read the documentation on [XSS prevention](#) for information on how to prevent this.

8.2.1 GSP Basics

In the next view sections we'll go through the basics of GSP and what is available to you. First off let's cover what you should be familiar with.

GSP supports the usage of `<% %>` scriptlet blocks to embed Groovy code (again this is discouraged):

```
<html>
  <body>
    <% out << "Hello GSP!" %>
  </body>
</html>
```

You can also use the `<%= %>` syntax to output values:

```
<html>
  <body>
    <%= "Hello GSP!" %>
  </body>
</html>
```

GSP also supports JSP-style server-side comments (which are not rendered in the HTML response) as the 1

```
<html>
  <body>
    <!-- This is my comment --%>
    <%= "Hello GSP!" %>
  </body>
</html>
```



Embedding data received from user input has the risk of making your application vulnerable (XSS) attack. Please read the documentation on [XSS prevention](#) for information on how to prevent

8.2.1.1 Variables and Scopes

Within the `<% %>` brackets you can declare variables:

```
<% now = new Date() %>
```

and then access those variables later in the page:

```
<%=now%>
```

Within the scope of a GSP there are a number of pre-defined variables, including:

- application - The [javax.servlet.ServletContext](#) instance
- applicationContext The Spring [ApplicationContext](#) instance
- flash - The [flash](#) object
- grailsApplication - The [GrailsApplication](#) instance
- out - The response writer for writing to the output stream
- params - The [params](#) object for retrieving request parameters
- request - The [HttpServletRequest](#) instance
- response - The [HttpServletResponse](#) instance
- session - The [HttpSession](#) instance
- webRequest - The [GrailsWebRequest](#) instance

8.2.1.2 Logic and Iteration

Using the `<% %>` syntax you can embed loops and so on using this syntax:

```
<html>
  <body>
    <% [1,2,3,4].each { num -> %>
      <p><%= "Hello ${num}!" %></p>
    <%}%>
  </body>
</html>
```

As well as logical branching:

```
<html>
  <body>
    <% if (params.hello == 'true')%>
      <%= "Hello!" %>
    <% else %>
      <%= "Goodbye!" %>
    </body>
</html>
```

8.2.1.3 Page Directives

GSP also supports a few JSP-style page directives.

The import directive lets you import classes into the page. However, it is rarely needed due to Groovy's de

```
<%@ page import="java.awt.*" %>
```

GSP also supports the contentType directive:

```
<%@ page contentType="application/json" %>
```

The contentType directive allows using GSP to render other formats.

8.2.1.4 Expressions

In GSP the `<%= %>` syntax introduced earlier is rarely used due to the support for GSP expressions. A G or a Groovy GString and takes the form `${expr}`:

```
<html>
  <body>
    Hello ${params.name}
  </body>
</html>
```

However, unlike JSP EL you can have any Groovy expression within the `${ . . }` block.



Embedding data received from user input has the risk of making your application vulnerable to a (XSS) attack. Please read the documentation on [XSS prevention](#) for information on how to pre

8.2.2 GSP Tags

Now that the less attractive JSP heritage has been set aside, the following sections cover GSP's built-in tags and pages.



The section on [Tag Libraries](#) covers how to add your own custom tag libraries.

All built-in GSP tags start with the prefix `g:`. Unlike JSP, you don't specify any tag library imports. If a tag is not a GSP tag. An example GSP tag would look like:

```
<g:example />
```

GSP tags can also have a body such as:

```
<g:example>
  Hello world
</g:example>
```

Expressions can be passed into GSP tag attributes, if an expression is not used it will be assumed to be a String.

```
<g:example attr="${new Date()}">
  Hello world
</g:example>
```

Maps can also be passed into GSP tag attributes, which are often used for a named parameter style syntax:

```
<g:example attr="${new Date()}" attr2="[one:1, two:2, three:3]">
  Hello world
</g:example>
```

Note that within the values of attributes you must use single quotes for Strings:

```
<g:example attr="${new Date()}" attr2="[one:'one', two:'two']">
  Hello world
</g:example>
```

With the basic syntax out the way, the next sections look at the tags that are built into Grails by default.

8.2.2.1 Variables and Scopes

Variables can be defined within a GSP using the [set](#) tag:

```
<g:set var="now" value="${new Date()}" />
```

Here we assign a variable called `now` to the result of a GSP expression (which simply constructs a new `Date` object). The body of the `<g:set>` tag to define a variable:

```
<g:set var="myHTML">
  Some re-usable code on: ${new Date()}
</g:set>
```

The assigned value can also be a bean from the `applicationContext`:

```
<g:set var="bookService" bean="bookService" />
```

Variables can also be placed in one of the following scopes:

- `page` - Scoped to the current page (default)
- `request` - Scoped to the current request
- `flash` - Placed within [flash](#) scope and hence available for the next request
- `session` - Scoped for the user session
- `application` - Application-wide scope.

To specify the scope, use the `scope` attribute:

```
<g:set var="now" value="${new Date()}" scope="request" />
```

8.2.2.2 Logic and Iteration

GSP also supports logical and iterative tags out of the box. For logic there are [if](#), [else](#) and [elseif](#) tags for use

```
<g:if test="${session.role == 'admin'}">
  <%-- show administrative functions --%>
</g:if>
<g:else>
  <%-- show basic functions --%>
</g:else>
```

Use the [each](#) and [while](#) tags for iteration:

```
<g:each in="${[1,2,3]}" var="num">
  <p>Number ${num}</p>
</g:each>

<g:set var="num" value="${1}" />
<g:while test="${num < 5 }">
  <p>Number ${num++}</p>
</g:while>
```

8.2.2.3 Search and Filtering

If you have collections of objects you often need to sort and filter them. Use the [findAll](#) and [grep](#) tags for t

```
Stephen King's Books:
<g:findAll in="${books}" expr="it.author == 'Stephen King'">
  <p>Title: ${it.title}</p>
</g:findAll>
```

The `expr` attribute contains a Groovy expression that can be used as a filter. The [grep](#) tag does a similar job

```
<g:grep in="${books}" filter="NonFictionBooks.class">
  <p>Title: ${it.title}</p>
</g:grep>
```

Or using a regular expression:

```
<g:grep in="${books.title}" filter="~/.*?Groovy.*?/">
  <p>Title: ${it}</p>
</g:grep>
```

The above example is also interesting due to its usage of GPath. GPath is an XPath-like language in Groovy instances. Since each Book has a `title`, you can obtain a list of Book titles using the expression `books.title`. The `books` collection, obtain each title, and return a new list!

8.2.2.4 Links and Resources

GSP also features tags to help you manage linking to controllers and actions. The [link](#) tag lets you specify a link that will automatically work out the link based on the [URL Mappings](#), even if you change them! For example:

```
<g:link action="show" id="1">Book 1</g:link>
<g:link action="show" id="${currentBook.id}">${currentBook.name}</g:link>
<g:link controller="book">Book Home</g:link>
<g:link controller="book" action="list">Book List</g:link>
<g:link url="[action: 'list', controller: 'book']">Book List</g:link>
<g:link params="[sort: 'title', order: 'asc', author: currentBook.author]"
  action="list">Book List</g:link>
```

8.2.2.5 Forms and Fields

Form Basics

GSP supports many different tags for working with HTML forms and fields, the most basic of which is the `form` tag, a version of the regular HTML form tag. The `url` attribute lets you specify which controller and action to run.


```
<g:form name="myForm" url="[controller:'book',action:'list']">...</g:form>
```

In this case we create a form called `myForm` that submits to the `BookController`'s `list` action. Beyond

Form Fields

In addition to easy construction of forms, GSP supports custom tags for dealing with different types of field

- [textField](#) - For input fields of type 'text'
- [passwordField](#) - For input fields of type 'password'
- [checkBox](#) - For input fields of type 'checkbox'
- [radio](#) - For input fields of type 'radio'
- [hiddenField](#) - For input fields of type 'hidden'
- [select](#) - For dealing with HTML select boxes

Each of these allows GSP expressions for the value:

```
<g:textField name="myField" value="${myValue}" />
```

GSP also contains extended helper versions of the above tags such as [radioGroup](#) (for creating groups of radio buttons) and [timeZoneSelect](#) (for selecting locales, currencies and time zones respectively).

Multiple Submit Buttons

The age old problem of dealing with multiple submit buttons is also handled elegantly with Grails using `g:actionSubmit`, but lets you specify an alternative action to submit to:

```
<g:actionSubmit value="Some update label" action="update" />
```

8.2.2.6 Tags as Method Calls

One major difference between GSP tags and other tagging technologies is that GSP tags can be called : [controllers](#), [tag libraries](#) or GSP views.

Tags as method calls from GSPs

Tags return their results as a String-like object (a `StreamCharBuffer` which has all of the same methods) response when called as methods. For example:

```
Static Resource: ${createLinkTo(dir: "images", file: "logo.jpg")}
```

This is particularly useful for using a tag within an attribute:

```

```

In view technologies that don't support this feature you have to nest tags within tags, which becomes messy in WYSIWYG tools such as Dreamweaver that attempt to render the mark-up as it is not well-formed:

```
" />
```

Tags as method calls from Controllers and Tag Libraries

You can also invoke tags from controllers and tag libraries. Tags within the default `g:` [namespace](#) `StreamCharBuffer` result is returned:

```
def imageLocation = createLinkTo(dir:"images", file:"logo.jpg").toString()
```

Prefix the namespace to avoid naming conflicts:

```
def imageLocation = g.createLinkTo(dir:"images", file:"logo.jpg").toString()
```

For tags that use a [custom namespace](#), use that prefix for the method call. For example (from the [FCK Edit](#)

```
def editor = fckeditor.editor(name: "text", width: "100%", height: "400")
```

8.2.3 Views and Templates

Grails also has the concept of templates. These are useful for partitioning your views into maintainable highly re-usable mechanism for structured views.

Template Basics

Grails uses the convention of placing an underscore before the name of a view to identify it as a template renders Books located at `grails-app/views/book/_bookTemplate.gsp`:

```
<div class="book" id="${book?.id}">
  <div>Title: ${book?.title}</div>
  <div>Author: ${book?.author?.name}</div>
</div>
```

Use the [render](#) tag to render this template from one of the views in `grails-app/views/book`:

```
<g:render template="bookTemplate" model="[book: myBook]" />
```

Notice how we pass into a model to use using the `model` attribute of the `render` tag. If you have multiple templates for each Book using the `render` tag with a `collection` attribute:

```
<g:render template="bookTemplate" var="book" collection="${bookList}" />
```

Shared Templates

In the previous example we had a template that was specific to the `BookController` and its views at may want to share templates across your application.

In this case you can place them in the root views directory at `grails-app/views` or any subdirectory below it use an absolute location starting with `/` instead of a relative location. For example `grails-app/views/shared/_mySharedTemplate.gsp`, you would reference it as:

```
<g:render template="/shared/mySharedTemplate" />
```

You can also use this technique to reference templates in any directory from any view or controller:

```
<g:render template="/book/bookTemplate" model="[book: myBook]" />
```

The Template Namespace

Since templates are used so frequently there is a template namespace, called `tmpl`, available that makes the following usage pattern:

```
<g:render template="bookTemplate" model="[book:myBook]" />
```

This can be expressed with the `tmpl` namespace as follows:

```
<tmpl:bookTemplate book="${myBook}" />
```

Templates in Controllers and Tag Libraries

You can also render templates from controllers using the [render](#) controller method. This is useful for Java small HTML or data responses to partially update the current page instead of performing new request:

```
def bookData() {
    def b = Book.get(params.id)
    render(template: "bookTemplate", model:[book:b])
}
```

The [render](#) controller method writes directly to the response, which is the most common behaviour. To instead use the [render](#) tag:

```
def bookData() {
    def b = Book.get(params.id)
    String content = g.render(template: "bookTemplate", model:[book:b])
    render content
}
```

Notice the usage of the `g` namespace which tells Grails we want to use the [tag as method call](#) instead of the

8.2.4 Layouts with Sitemesh

Creating Layouts

Grails leverages [Sitemesh](#), a decorator engine, to support view layouts. Layouts are located in the `grails` layout can be seen below:

```

<html>
  <head>
    <title><g:layoutTitle default="An example decorator" /></title>
    <g:layoutHead />
  </head>
  <body onload="\${pageProperty(name: 'body.onload')}">
    <div class="menu"><!--my common menu goes here--></div>
    <div class="body">
      <g:layoutBody />
    </div>
  </body>
</html>

```

The key elements are the [layoutHead](#), [layoutTitle](#) and [layoutBody](#) tag invocations:

- `layoutTitle` - outputs the target page's title
- `layoutHead` - outputs the target page's head tag contents
- `layoutBody` - outputs the target page's body tag contents

The previous example also demonstrates the [pageProperty](#) tag which can be used to inspect and return aspects of the page.

Triggering Layouts

There are a few ways to trigger a layout. The simplest is to add a meta tag to the view:

```

<html>
  <head>
    <title>An Example Page</title>
    <meta name="layout" content="main" />
  </head>
  <body>This is my content!</body>
</html>

```

In this case a layout called `grails-app/views/layouts/main.gsp` will be used to layout the previous section the output would resemble this:

```

<html>
  <head>
    <title>An Example Page</title>
  </head>
  <body onload="">
    <div class="menu"><!--my common menu goes here--></div>
    <div class="body">
      This is my content!
    </div>
  </body>
</html>

```

Specifying A Layout In A Controller

Another way to specify a layout is to specify the name of the layout by assigning a value to the "layout" property of a controller such as:

```

class BookController {
  static layout = 'customer'
  def list() { ... }
}

```

You can create a layout called `grails-app/views/layouts/customer.gsp` which will be applied to the views rendered by the controller. The value of the "layout" property may contain a directory structure relative to the `grails-app` directory. For example:

```

class BookController {
  static layout = 'custom/customer'
  def list() { ... }
}

```

Views rendered from that controller would be decorated with the `grails-app/views/layouts/custom/customer.gsp` layout.

Layout by Convention

Another way to associate layouts is to use "layout by convention". For example, if you have this controller

```
class BookController {
    def list() { ... }
}
```

You can create a layout called `grails-app/views/layouts/book.gsp`, which will be applied to the `list` action. If no layout is found, Grails will delegate to.

Alternatively, you can create a layout called `grails-app/views/layouts/book/list.gsp` within the `BookController`.

If you have both the above mentioned layouts in place the layout specific to the action will take precedence.

If a layout may not be located using any of those conventions, the convention of last resort is to look for `grails-app/views/layouts/application.gsp`. The name of the application default layout is `grails-app/conf/application.groovy` as follows:

```
grails.sitemesh.default.layout = 'myLayoutName'
```

With that property in place, the application default layout will be `grails-app/views/layouts/myLayout.gsp`.

Inline Layouts

Grails' also supports Sitemesh's concept of inline layouts with the [applyLayout](#) tag. This can be used to wrap a section of content. This lets you even further modularize your view structure by "decorating" your templates.

Some examples of usage can be seen below:

```
<g:applyLayout name="myLayout" template="bookTemplate" collection="${books}" />
<g:applyLayout name="myLayout" url="http://www.google.com" />
<g:applyLayout name="myLayout">
  The content to apply a layout to
</g:applyLayout>
```

Server-Side Includes

While the [applyLayout](#) tag is useful for applying layouts to external content, if you simply want to include content from another template, you can use the [include](#) tag:


```
<g:include controller="book" action="list" />
```

You can even combine the [include](#) tag and the [applyLayout](#) tag for added flexibility:

```
<g:applyLayout name="myLayout">  
  <g:include controller="book" action="list" />  
</g:applyLayout>
```

Finally, you can also call the [include](#) tag from a controller or tag library as a method:

```
def content = include(controller:"book", action:"list")
```

The resulting content will be provided via the return value of the [include](#) tag.

8.2.5 Static Resources

Grails 2.0 integrates with the [Asset Pipeline plugin](#) to provide sophisticated static asset management. T applications.

The basic way to include a link to a static asset in your application is to use the [resource](#) tag. This simple a

However modern applications with dependencies on multiple JavaScript and CSS libraries and framework (plugins) require something more powerful.

The issues that the Asset-Pipeline plugin tackles are:

- Reduced Dependence - The plugin has compression, minification, and cache-digests built in.
- Easy Debugging - Makes for easy debugging by keeping files separate in development mode.
- Asset Bundling using require [directives](#).
- Web application performance tuning is difficult.
- The need for a standard way to expose static assets in plugins and applications.
- The need for extensible processing to make languages like LESS or Coffee first class citizens.

The asset-pipeline allows you to define your javascript or css requirements right at the top of the file and th

Take a look at the [documentation](#) for the asset-pipeline to get started.

If you do not want to use the Asset-Pipeline plugin, you can serve the static assets from directories `src/main/resources` the latter one only gets included in WAR packaging but not in JAR packaging.

8.2.6 Sitemesh Content Blocks

Although it is useful to decorate an entire page sometimes you may find the need to decorate independent content blocks. To get started, partition the page to be decorated using the `<content>` tag:

```
<content tag="navbar">
... draw the navbar here...
</content>

<content tag="header">
... draw the header here...
</content>

<content tag="footer">
... draw the footer here...
</content>

<content tag="body">
... draw the body here...
</content>
```

Then within the layout you can reference these components and apply individual layouts to each:

```
<html>
  <body>
    <div id="header">
      <g:applyLayout name="headerLayout">
        <g:pageProperty name="page.header" />
      </g:applyLayout>
    </div>
    <div id="nav">
      <g:applyLayout name="navLayout">
        <g:pageProperty name="page.navbar" />
      </g:applyLayout>
    </div>
    <div id="body">
      <g:applyLayout name="bodyLayout">
        <g:pageProperty name="page.body" />
      </g:applyLayout>
    </div>
    <div id="footer">
      <g:applyLayout name="footerLayout">
        <g:pageProperty name="page.footer" />
      </g:applyLayout>
    </div>
  </body>
</html>
```

8.2.7 Making Changes to a Deployed Application

One of the main issues with deploying a Grails application (or typically any servlet-based one) is that any change to your whole application. If all you want to do is fix a typo on a page, or change an image link, it can seem tedious. Fortunately, Grails does have a solution: the `grails.gsp.view.dir` configuration setting.

How does this work? The first step is to decide where the GSP files should go. Let's say `/var/www/grails/my-app` directory. We add these two lines to `grails-app/conf/application.yml`:

```
grails.gsp.enable.reload = true
grails.gsp.view.dir = "/var/www/grails/my-app/"
```

The first line tells Grails that modified GSP files should be reloaded at runtime. If you don't have this setting, the changes won't be reflected in the running application until you restart. The second line tells Grails where to look for GSP files.



The trailing slash on the `grails.gsp.view.dir` value is important! Without it, Grails will look for GSP files in the application directory.

Setting "`grails.gsp.view.dir`" is optional. If it's not specified, you can update files directly to the application server, these files might get overwritten when the server is restarted. Most application servers support this in the recommended way.

With those settings in place, all you need to do is copy the views from your web application to the external server. It should look something like this:

```
mkdir -p /var/www/grails/my-app/grails-app/views
cp -R grails-app/views/* /var/www/grails/my-app/grails-app/views
```

The key point here is that you must retain the view directory structure, including the `grails-app/views` directory.

One thing to bear in mind with this technique is that every time you modify a GSP, it uses up permgen space. If you get "out of permgen space" errors unless you restart the server. So this technique is not recommended for frequent updates.

There are also some System properties to control GSP reloading:

Name	Description
<code>grails.gsp.enable.reload</code>	alternative system property for enabling the GSP reload mode without changing the configuration
<code>grails.gsp.reload.interval</code>	interval between checking the lastmodified time of the gsp source file, unit is milliseconds
<code>grails.gsp.reload.granularity</code>	the number of milliseconds leeway to give before deciding a file is out of date. Roundings usually cause a 1000ms difference in lastmodified times

GSP reloading is supported for precompiled GSPs since Grails 1.3.5 .

8.2.8 GSP Debugging

Viewing the generated source code

- Adding "?showSource=true" or "&showSource=true" to the url shows the generated Groovy source code and show the source code of included templates. This only works in development mode
- The saving of all generated source code can be activated by setting the property "grails.views.gsp.keepSource". It must point to a directory that exists and is writable.
- During "grails war" gsp pre-compilation, the generated source code is stored in grails.home/.grails/(grails_version)/projects/(project name)/gspcompile).

Debugging GSP code with a debugger

- See [Debugging GSP in STS](#)

Viewing information about templates used to render a single url

GSP templates are reused in large web applications by using the `g:render` taglib. Several small templates can be hard to find out what GSP template actually renders the html seen in the result. The debug templates comments contain debug information about gsp templates used to render the page.

Usage is simple: append "?debugTemplates" or "&debugTemplates" to the url and view the source of the page. It is restricted to development mode. It won't work in production.

Here is an example of comments added by debugTemplates :

```
<!-- GSP #2 START template: /home/.../views/_carousel.gsp
      precompiled: false lastmodified: ... -->
.
.
.
<!-- GSP #2 END template: /home/.../views/_carousel.gsp
      rendering time: 115 ms -->
```

Each comment block has a unique id so that you can find the start & end of each template call.

8.3 Tag Libraries

Like [Java Server Pages](#) (JSP), GSP supports the concept of custom tag libraries. Unlike JSP, Grails' tag libraries are completely reloadable at runtime.

Quite simply, to create a tag library create a Groovy class that ends with the convention `TagLib` in a directory:

```
class SimpleTagLib {  
}
```

Now to create a tag create a Closure property that takes two arguments: the tag attributes and the body con

```
class SimpleTagLib {  
  def simple = { attrs, body ->  
}
```

The `attrs` argument is a Map of the attributes of the tag, whilst the `body` argument is a Closure that retu

```
class SimpleTagLib {  
  def emoticon = { attrs, body ->  
    out << body() << (attrs.happy == 'true' ? " :-)" : " :-( "  
  }  
}
```

As demonstrated above there is an implicit `out` variable that refers to the output `Writer` which you can reference the tag inside your GSP; no imports are necessary:

```
<g:emoticon happy="true">Hi John</g:emoticon>
```



To help IDEs like Spring Tool Suite (STS) and others autocomplete tag attributes, you should prefix your tag closures with `@attr` descriptions. Since taglibs use Groovy code it can be difficult to write these attributes.

For example:

```
class SimpleTagLib {  
    /**  
     * Renders the body with an emoticon.  
     *  
     * @attr happy whether to show a happy emoticon ('true') or  
     * a sad emoticon ('false')  
     */  
    def emoticon = { attrs, body ->  
        out << body() << (attrs.happy == 'true' ? " :-)" : " :-(")  
    }  
}
```

and any mandatory attributes should include the **REQUIRED** keyword, e.g.

```
class SimpleTagLib {  
    /**  
     * Creates a new password field.  
     *  
     * @attr name REQUIRED the field name  
     * @attr value the field value  
     */  
    def passwordField = { attrs ->  
        attrs.type = "password"  
        attrs.tagName = "passwordField"  
        fieldImpl(out, attrs)  
    }  
}
```

8.3.1 Variables and Scopes

Within the scope of a tag library there are a number of pre-defined variables including:

- `actionName` - The currently executing action name
- `controllerName` - The currently executing controller name
- `flash` - The [flash](#) object
- `grailsApplication` - The [GrailsApplication](#) instance
- `out` - The response writer for writing to the output stream
- `pageScope` - A reference to the [pageScope](#) object used for GSP rendering (i.e. the binding)
- `params` - The [params](#) object for retrieving request parameters
- `pluginContextPath` - The context path to the plugin that contains the tag library
- `request` - The [HttpServletRequest](#) instance
- `response` - The [HttpServletResponse](#) instance
- `servletContext` - The [javax.servlet.ServletContext](#) instance
- `session` - The [HttpSession](#) instance

8.3.2 Simple Tags

As demonstrated in the previous example it is easy to write simple tags that have no body and just output style tag:

```
def dateFormat = { attrs, body ->
    out << new java.text.SimpleDateFormat(attrs.format).format(attrs.date)
}
```

The above uses Java's `SimpleDateFormat` class to format a date and then write it to the response. The

```
<g:dateFormat format="dd-MM-yyyy" date="${new Date()}" />
```

With simple tags sometimes you need to write HTML mark-up to the response. One approach would be to

```
def formatBook = { attrs, body ->
  out << "<div id='${attrs.book.id}'>"
  out << "Title : ${attrs.book.title}"
  out << "</div>"
}
```

Although this approach may be tempting it is not very clean. A better approach would be to reuse the [render](#)

```
def formatBook = { attrs, body ->
  out << render(template: "bookTemplate", model: [book: attrs.book])
}
```

And then have a separate GSP template that does the actual rendering.

8.3.3 Logical Tags

You can also create logical tags where the body of the tag is only output once a set of conditions have security tags:

```
def isAdmin = { attrs, body ->
  def user = attrs.user
  if (user && checkUserPrivs(user)) {
    out << body()
  }
}
```

The tag above checks if the user is an administrator and only outputs the body content if he/she has the cor

```
<g:isAdmin user='${myUser}'>
  // some restricted content
</g:isAdmin>
```

8.3.4 Iterative Tags

Iterative tags are easy too, since you can invoke the body multiple times:

```
def repeat = { attrs, body ->
    attrs.times?.toInteger()?.times { num ->
        out << body(num)
    }
}
```

In this example we check for a `times` attribute and if it exists convert it to a number, then use Groovy's `times` method to repeat the body:

```
<g:repeat times="3">
<p>Repeat this 3 times! Current repeat = ${it}</p>
</g:repeat>
```

Notice how in this example we use the implicit `it` variable to refer to the current number. This works because the current value is passed into the iteration:

```
out << body(num)
```

That value is then passed as the default variable `it` to the tag. However, if you have nested tags this can lead to conflicts with variables that the body uses:

```
def repeat = { attrs, body ->
    def var = attrs.var ? "num" : "it"
    attrs.times?.toInteger()?.times { num ->
        out << body((var):num)
    }
}
```

Here we check if there is a `var` attribute and if there is use that as the name to pass into the body invocation.

```
out << body((var):num)
```



Note the usage of the parenthesis around the variable name. If you omit these Groovy assumes you are referring to the variable itself.

Now we can change the usage of the tag as follows:

```
<g:repeat times="3" var="j">  
<p>Repeat this 3 times! Current repeat = ${j}</p>  
</g:repeat>
```

Notice how we use the `var` attribute to define the name of the variable `j` and then we are able to reference

8.3.5 Tag Namespaces

By default, tags are added to the default Grails namespace and are used with the `g:` prefix in GSP pages. It is possible to use a different namespace by adding a static property to your `TagLib` class:

```
class SimpleTagLib {  
    static namespace = "my"  
    def example = { attrs ->  
        ""  
    }  
}
```

Here we have specified a namespace of `my` and hence the tags in this tag lib must then be referenced from

```
<my:example name="..." />
```

where the prefix is the same as the value of the static `namespace` property. Namespaces are particularly useful

Tags within namespaces can be invoked as methods using the namespace as a prefix to the method call:

```
out << my.example(name: "foo")
```

This works from GSP, controllers or tag libraries.

8.3.6 Using JSP Tag Libraries

In addition to the simplified tag library mechanism provided by GSP, you can also use JSP tags from GSP. `taglib` directive:

```
<%@ taglib prefix="fmt" uri="http://java.sun.com/jsp/jstl/fmt" %>
```

Besides this you have to configure Grails to scan for the JSP tld files. This is configured with the `grails` comma separated String value. Spring's `PathMatchingResourcePatternResolver` is used to resolve the pattern.

For example you could scan for all available tld files by adding this to `application.groovy`:

```
grails.gsp.tldScanPattern='classpath*:META-INF/*.tld,/WEB-INF/tld/*.tld'
```

JSTL standard library is no more added as a dependency by default. In case you are using JSTL, `build.gradle`:

```
runtime 'javax.servlet:jstl:1.1.2'
runtime 'taglibs:standard:1.1.2'
```

Then you can use JSP tags like any other tag:

```
<fmt:formatNumber value="${10}" pattern=".00"/>
```

With the added bonus that you can invoke JSP tags like methods:

```
${fmt.formatNumber(value:10, pattern:".00")}
```

8.3.7 Tag return value

A taglib can be used in a GSP as an ordinary tag or it might be used as a function in other taglibs or GSP expressions.

Internally Grails intercepts calls to taglib closures. The "out" that is available in a taglib is mapped to a java.io.PrintWriter object that "captures" the output of the taglib call. This buffer is the return value of a tag library call when used as a function.

If the tag is listed in the library's static `returnObjectForTags` array, then its return value will be wrapped in an output buffer. The return value of the tag lib closure will be returned as-is if it's used as a function in GSP expressions or as a tag.

If the tag is not included in the `returnObjectForTags` array, then its return value will be discarded. Using a taglib as a function is not supported.

Example:

```
class ObjectReturningTagLib {
    static namespace = "cms"
    static returnObjectForTags = ['content']

    def content = { attrs, body ->
        CmsContent.findByCode(attrs.code)?.content
    }
}
```

Given this example `cms.content(code:'something')` call in another taglib or GSP expression would return the result of the call without wrapping the return value in a buffer. It might be worth doing so also because of performance. You can wrap the tag return value in an output buffer in such cases.

8.4 URL Mappings

Throughout the documentation so far the convention used for URLs has been the default of `/controller/action`, which is not hard wired into Grails and is in fact controlled by a URL Mappings class located at `grails-app/conf/UrlMappings.groovy`.

The `UrlMappings` class contains a single property called `mappings` that has been assigned a block of code that defines the URL mappings for the application.

```
class UrlMappings {  
    static mappings = {  
    }  
}
```

8.4.1 Mapping to Controllers and Actions

To create a simple mapping simply use a relative URL as the method name and specify named parameters

```
"/product"(controller: "product", action: "list")
```

In this case we've mapped the URL `/product` to the `list` action of the `ProductController`. `C` action of the controller:

```
"/product"(controller: "product")
```

An alternative syntax is to assign the controller and action to use within a block passed to the method:

```
"/product" {  
    controller = "product"  
    action = "list"  
}
```

Which syntax you use is largely dependent on personal preference.

If you have mappings that all fall under a particular path you can group mappings with the `group` method

```
group "/product", {  
  "/apple"(controller:"product", id:"apple")  
  "/htc"(controller:"product", id:"htc")  
}
```

You can also create nested group url mappings:

```
group "/store", {  
  group "/product", {  
    "$id"(controller:"product")  
  }  
}
```

To rewrite one URI onto another explicit URI (rather than a controller/action pair) do something like this:

```
"/hello"(uri: "/hello.dispatch")
```

Rewriting specific URIs is often useful when integrating with other frameworks.

8.4.2 Mapping to REST resources

Since Grails 2.3, it's possible to create RESTful URL mappings that map onto controllers by convention. The

```
"/books"(resources:'book')
```

You define a base URI and the name of the controller to map to using the `resources` parameter. The ab

HTTP Method	URI	Grails Action
GET	/books	index
GET	/books/create	create
POST	/books	save
GET	/books/\${id}	show
GET	/books/\${id}/edit	edit
PUT	/books/\${id}	update
DELETE	/books/\${id}	delete

If you are not sure which mapping will be generated for your case just run the command `url-mappings` you a really neat report for all the url mappings.

If you wish to include or exclude any of the generated URL mappings you can do so with the `include` name of the Grails action to include or exclude:

```
"/books"(resources:'book', excludes:['delete', 'update'])
or
"/books"(resources:'book', includes:['index', 'show'])
```

Explicit REST Mappings

As of Grails 3.1, if you prefer not to rely on the a `resources` mapping to define your mappings then you can use the `method` name (in lower case) to indicate the HTTP method it applies to. The following URL mapping:

```
"/books"(resources:'book')
```

Is equivalent to:

```

get "/books"(controller:"book", action:"index")
get "/books/create"(controller:"book", action:"create")
post "/books"(controller:"book", action:"save")
get "/books/$id"(controller:"book", action:"show")
get "/books/$id/edit"(controller:"book", action:"edit")
put "/books/$id"(controller:"book", action:"update")
delete "/books/$id"(controller:"book", action:"delete")

```

Notice how the HTTP method name is prefixed prior to each URL mapping definition.

Single resources

A single resource is a resource for which there is only one (possibly per user) in the system. You can parameter (as oppose to resources):

```

"/book"(resource:'book')

```

This results in the following URL mappings:

HTTP Method	URI	Grails Action
GET	/book/create	create
POST	/book	save
GET	/book	show
GET	/book/edit	edit
PUT	/book	update
DELETE	/book	delete

The main difference is that the id is not included in the URL mapping.

Nested Resources

You can nest resource mappings to generate child resources. For example:


```

"/books"(resources:'book') {
  "/authors"(resources:"author")
}

```

The above will result in the following URL mappings:

HTTP Method	URL	Grails Action
GET	/books/\${bookId}/authors	index
GET	/books/\${bookId}/authors/create	create
POST	/books/\${bookId}/authors	save
GET	/books/\${bookId}/authors/\${id}	show
GET	/books/\${bookId}/authors/edit/\${id}	edit
PUT	/books/\${bookId}/authors/\${id}	update
DELETE	/books/\${bookId}/authors/\${id}	delete

You can also nest regular URL mappings within a resource mapping:

```

"/books"(resources: "book") {
  "/publisher"(controller:"publisher")
}

```

This will result in the following URL being available:

HTTP Method	URL	Grails Action
GET	/books/1/publisher	index

To map a URI directly below a resource then use a collection:

```

"/books"(resources: "book") {
  collection {
    "/publisher"(controller:"publisher")
  }
}

```

This will result in the following URL being available (without the ID):

HTTP Method	URL	Grails Action
GET	/books/publisher	index

Linking to RESTful Mappings

You can link to any URL mapping created with the `g:link` tag provided by Grails simply by referencing

```
<g:link controller="book" action="index">My Link</g:link>
```

As a convenience you can also pass a domain instance to the `resource` attribute of the `link` tag:

```
<g:link resource="${book}">My Link</g:link>
```

This will automatically produce the correct link (in this case `/books/1` for an id of `"1"`).

The case of nested resources is a little different as they typically required two identifiers (the id of the example given the nested resources:

```
"/books"(resources:'book') {  
  "/authors"(resources:"author")  
}
```

If you wished to link to the `show` action of the `author` controller, you would write:

```
// Results in /books/1/authors/2  
<g:link controller="author" action="show" method="GET" params="[bookId:1]" id="2">
```

However, to make this more concise there is a `resource` attribute to the `link` tag which can be used inste

```
// Results in /books/1/authors/2
<g:link resource="book/author" action="show" bookId="1" id="2">My Link</g:link>
```

The resource attribute accepts a path to the resource separated by a slash (in this case "book/author"). The necessary `bookId` parameter.

8.4.3 Redirects In URL Mappings

Since Grails 2.3, it is possible to define URL mappings which specify a redirect. When a URL mapping matches an incoming request, a redirect is initiated with information provided by the mapping.

When a URL mapping specifies a redirect the mapping must either supply a String representing a URI to the target of the redirect. That Map is structured just like the Map that may be passed as an argument to the

```
"/viewBooks"(redirect: '/books/list')
"/viewAuthors"(redirect: [controller: 'author', action: 'list'])
"/viewPublishers"(redirect: [controller: 'publisher', action: 'list', permanent:
```

Request parameters that were part of the original request will be included in the redirect.

8.4.4 Embedded Variables

Simple Variables

The previous section demonstrated how to map simple URLs with concrete "tokens". In URL mapping between each slash, '/'. A concrete token is one which is well defined such as `/product`. However, the value of a particular token will be until runtime. In this case you can use variable placeholders within the U

```
static mappings = {
  "/product/$id"(controller: "product")
}
```

In this case by embedding a `$id` variable as the second token Grails will automatically map the second token (object) called `id`. For example given the URL `/product/MacBook`, the following code will render "M

```
class ProductController {  
  def index() { render params.id }  
}
```

You can of course construct more complex examples of mappings. For example the traditional blog URL f

```
static mappings = {  
  "$blog/$year/$month/$day/$id"(controller: "blog", action: "show")  
}
```

The above mapping would let you do things like:

```
/graemerocher/2007/01/10/my_funky_blog_entry
```

The individual tokens in the URL would again be mapped into the [params](#) object with values available for

Dynamic Controller and Action Names

Variables can also be used to dynamically construct the controller and action name. In fact the default Grai

```
static mappings = {  
  "$controller/$action?/$id?"()  
}
```

Here the name of the controller, action and id are implicitly obtained from the variables `controller`, `ac`

You can also resolve the controller name and action name to execute dynamically using a closure:

```
static mappings = {
    "$controller" {
        action = { params.goHere }
    }
}
```

Optional Variables

Another characteristic of the default mapping is the ability to append a ? at the end of a variable to make a technique could be applied to the blog URL mapping to have more flexible linking:

```
static mappings = {
    "$blog/$year?/$month?/$day?/$id?"(controller:"blog", action:"show")
}
```

With this mapping all of these URLs would match with only the relevant parameters being populated in the

```
/graemerocher/2007/01/10/my_funky_blog_entry
/graemerocher/2007/01/10
/graemerocher/2007/01
/graemerocher/2007
/graemerocher
```

Optional File Extensions

If you wish to capture the extension of a particular path, then a special case mapping exists:

```
"/$controller/$action?/$id?(.$format)?"()
```

By adding the (.\$format) ? mapping you can access the file extension using the response.format

```
def index() {  
  render "extension is ${response.format}"  
}
```

Arbitrary Variables

You can also pass arbitrary parameters from the URL mapping into the controller by just setting them in th

```
"/holiday/win" {  
  id = "Marrakech"  
  year = 2007  
}
```

This variables will be available within the [params](#) object passed to the controller.

Dynamically Resolved Variables

The hard coded arbitrary variables are useful, but sometimes you need to calculate the name of the variable by assigning a block to the variable name:

```
"/holiday/win" {  
  id = { params.id }  
  isEligible = { session.user != null } // must be logged in  
}
```

In the above case the code within the blocks is resolved when the URL is actually matched and hence can l

8.4.5 Mapping to Views

You can resolve a URL to a view without a controller or action involved. For example to map `grails-app/views/index.gsp` you could use:

```
static mappings = {
    "/"(view: "/index") // map the root URL
}
```

Alternatively if you need a view that is specific to a given controller you could use:

```
static mappings = {
    "/help"(controller: "site", view: "help") // to a view for a controller
}
```

8.4.6 Mapping to Response Codes

Grails also lets you map HTTP response codes to controllers, actions or views. Just use a method name then in:

```
static mappings = {
    "403"(controller: "errors", action: "forbidden")
    "404"(controller: "errors", action: "notFound")
    "500"(controller: "errors", action: "serverError")
}
```

Or you can specify custom error pages:

```
static mappings = {
    "403"(view: "/errors/forbidden")
    "404"(view: "/errors/notFound")
    "500"(view: "/errors/serverError")
}
```

Declarative Error Handling

In addition you can configure handlers for individual exceptions:

```
static mappings = {
    "403"(view: "/errors/forbidden")
    "404"(view: "/errors/notFound")
    "500"(controller: "errors", action: "illegalArgument",
        exception: IllegalArgumentException)
    "500"(controller: "errors", action: "nullPointer",
        exception: NullPointerException)
    "500"(controller: "errors", action: "customException",
        exception: MyException)
    "500"(view: "/errors/serverError")
}
```

With this configuration, an `IllegalArgumentException` will be handled by the `illegalArgument` action, a `NullPointerException` will be handled by the `nullPointer` action, and a `MyException` will be handled by the `customException` action. Other exceptions will be handled by the catch-all rule and use the `/errors/serverError` view.

You can access the exception from your custom error handling view or controller action using the request's `exception` property.

```
class ErrorController {
    def handleError() {
        def exception = request.exception
        // perform desired processing to handle the exception
    }
}
```



If your error-handling controller action throws an exception as well, you'll end up with a `StackOverflowError`.

8.4.7 Mapping to HTTP methods

URL mappings can also be configured to map based on the HTTP method (GET, POST, PUT or DELETE) by restricting mappings based on HTTP method.

As an example the following mappings provide a RESTful API URL mappings for the `ProductController`.

```
static mappings = {
    "/product/{id}"(controller: "product", action: "update", method: "PUT")
}
```


8.4.8 Mapping Wildcards

Grails' URL mappings mechanism also supports wildcard mappings. For example consider the following n

```
static mappings = {  
    "/images/*.jpg"(controller: "image")  
}
```

This mapping will match all paths to images such as /image/logo.jpg. Of course you can achieve the

```
static mappings = {  
    "/images/$name.jpg"(controller: "image")  
}
```

However, you can also use double wildcards to match more than one level below:

```
static mappings = {  
    "/images/**/*.jpg"(controller: "image")  
}
```

In this cases the mapping will match /image/logo.jpg as well as /image/other/logo.jpg variable:

```
static mappings = {  
    // will match /image/logo.jpg and /image/other/logo.jpg  
    "/images/$name/**/*.jpg"(controller: "image")  
}
```

In this case it will store the path matched by the wildcard inside a name parameter obtainable from the [par](#)

```
def name = params.name
println name // prints "logo" or "other/logo"
```

If you use wildcard URL mappings then you may want to exclude certain URIs from Grails' URL mappings. The `excludes` setting inside the `UrlMappings.groovy` class:

```
class UrlMappings {
    static excludes = ["/images/*", "/css/*"]
    static mappings = {
        ...
    }
}
```

In this case Grails won't attempt to match any URIs that start with `/images` or `/css`.

8.4.9 Automatic Link Re-Writing

Another great feature of URL mappings is that they automatically customize the behaviour of the [link](#) tag to go and change all of your links.

This is done through a URL re-writing technique that reverse engineers the links from the URL mappings in an earlier section:

```
static mappings = {
    "/$blog/$year?/$month?/$day?/$id?"(controller:"blog", action:"show")
}
```

If you use the link tag as follows:

```
<g:link controller="blog" action="show"
        params="[blog:'fred', year:2007]">
    My Blog
</g:link>

<g:link controller="blog" action="show"
        params="[blog:'fred', year:2007, month:10]">
    My Blog - October 2007 Posts
</g:link>
```

Grails will automatically re-write the URL in the correct format:

```
<a href="/fred/2007">My Blog</a>
<a href="/fred/2007/10">My Blog - October 2007 Posts</a>
```

8.4.10 Applying Constraints

URL Mappings also support Grails' unified [validation constraints](#) mechanism, which lets you further "cor" we revisit the blog sample code from earlier, the mapping currently looks like this:

```
static mappings = {
    "$blog/$year?/$month?/$day?/$id?"(controller:"blog", action:"show")
}
```

This allows URLs such as:

```
/graemerocher/2007/01/10/my_funky_blog_entry
```

However, it would also allow:

```
/graemerocher/not_a_year/not_a_month/not_a_day/my_funky_blog_entry
```

This is problematic as it forces you to do some clever parsing in the controller code. Luckily, URL Map URL tokens:

```
"/$blog/$year?/$month?/$day?/$id?" {  
    controller = "blog"  
    action = "show"  
    constraints {  
        year(matches:/\d{4}/)  
        month(matches:/\d{2}/)  
        day(matches:/\d{2}/)  
    }  
}
```

In this case the constraints ensure that the `year`, `month` and `day` parameters match a particular valid pattern.

8.4.11 Named URL Mappings

URL Mappings also support named mappings, that is mappings which have a name associated with them when links are generated.

The syntax for defining a named mapping is as follows:

```
static mappings = {  
    name <mapping name>: <url pattern> {  
        // ...  
    }  
}
```

For example:

```
static mappings = {  
  name personList: "/showPeople" {  
    controller = 'person'  
    action = 'list'  
  }  
  name accountDetails: "/details/$acctNumber" {  
    controller = 'product'  
    action = 'accountDetails'  
  }  
}
```

The mapping may be referenced in a link tag in a GSP.

```
<g:link mapping="personList">List People</g:link>
```

That would result in:

```
<a href="/showPeople">List People</a>
```

Parameters may be specified using the params attribute.

```
<g:link mapping="accountDetails" params="[acctNumber:'8675309']">  
  Show Account  
</g:link>
```

That would result in:

```
<a href="/details/8675309">Show Account</a>
```

Alternatively you may reference a named mapping using the link namespace.

```
<link:personList>List People</link:personList>
```

That would result in:

```
<a href="/showPeople">List People</a>
```

The link namespace approach allows parameters to be specified as attributes.

```
<link:accountDetails acctNumber="8675309">Show Account</link:accountDetails>
```

That would result in:

```
<a href="/details/8675309">Show Account</a>
```

To specify attributes that should be applied to the generated href, specify a Map value to the `attrs` attribute of the href, not passed through to be used as request parameters.

```
<link:accountDetails attrs="[class: 'fancy']" acctNumber="8675309">  
  Show Account  
</link:accountDetails>
```

That would result in:

```
<a href="/details/8675309" class="fancy">Show Account</a>
```

8.4.12 Customizing URL Formats

The default URL Mapping mechanism supports camel case names in the URLs. The default URL for a controller named `MathHelperController` would be something like `/mathHelper/addNumbers`. Grails provides a pattern and provides an implementation which replaces the camel case convention with a hyphenated URL `/math-helper/add-numbers`. To enable hyphenated URLs assign a value of "hyphenated" to the `grails.web.url.converter` in `grails-app/conf/application.groovy`.

```
// grails-app/conf/application.groovy
grails.web.url.converter = 'hyphenated'
```

Arbitrary strategies may be plugged in by providing a class which implements the [UrlConverter](#) interface and registers it in the application context with the bean name of `grails.web.UrlConverter.BEAN_NAME`. If Grails finds this class, it will be used as the default converter and there is no need to assign a value to the `grails.web.url.converter`.

```
// src/groovy/com/myapplication/MyUrlConverterImpl.groovy
package com.myapplication

class MyUrlConverterImpl implements grails.web.UrlConverter {

    String toUrlElement(String propertyOrClassName) {
        // return some representation of a property or class name that should be
    }
}
```

```
// grails-app/conf/spring/resources.groovy
beans = {
    "${grails.web.UrlConverter.BEAN_NAME}"(com.myapplication.MyUrlConverterImpl)
}
```

8.4.13 Namespaced Controllers

If an application defines multiple controllers with the same name in different packages, the controllers must define a namespace for a controller. To define a static property named `namespace` in the controller and assign it a value.

```
// grails-app/controllers/com/app/reporting/AdminController.groovy
package com.app.reporting

class AdminController {

    static namespace = 'reports'

    // ...
}
```

```
// grails-app/controllers/com/app/security/AdminController.groovy
package com.app.security

class AdminController {

    static namespace = 'users'

    // ...
}
```

When defining url mappings which should be associated with a namespaced controller, the namespace value is used to construct the url.

```
// grails-app/controllers/UrlMappings.groovy
class UrlMappings {

    static mappings = {
        '/userAdmin' {
            controller = 'admin'
            namespace = 'users'
        }

        '/reportAdmin' {
            controller = 'admin'
            namespace = 'reports'
        }

        "$namespace/$controller/$action?"()
    }
}
```


Reverse URL mappings also require that the namespace be specified.

```
<g:link controller="admin" namespace="reports">Click For Report Admin</g:link>
<g:link controller="admin" namespace="users">Click For User Admin</g:link>
```

When resolving a URL mapping (forward or reverse) to a namespaced controller, a mapping will only match if the application provides several controllers with the same name in different packages, at most 1 of them may have a namespace property, if there are multiple controllers with the same name that do not define a namespace property, the framework will not resolve them for forward or reverse mapping resolutions.

It is allowed for an application to use a plugin which provides a controller with the same name as a controller of the application to define a namespace property as long as the controllers are in separate packages. For example, a controller named `com.accounting.ReportingController` and the application may use a `com.humanresources.ReportingController`. The only issue with that is the URL mapping must be explicit in specifying that the mapping applies to the `ReportingController` which is provided by the plugin.

See the following example.

```
static mappings = {
    "/accountingReports" {
        controller = "reporting"
    }
    "/humanResourceReports" {
        controller = "reporting"
        plugin = "humanResources"
    }
}
```

With that mapping in place, a request to `/accountingReports` will be handled by the `ReportingController` of the application. A request to `/humanResourceReports` will be handled by the `ReportingController` of the `humanResources` plugin.

There could be any number of `ReportingController` controllers provided by any number of plugins. The framework will resolve the `ReportingController` even if they are defined in separate packages.

Assigning a value to the `plugin` variable in the mapping is only required if there are multiple controllers with the same name provided by the application and/or plugins. If the `humanResources` plugin provides a `ReportingController` available at runtime, the following mapping would work.

```
static mappings = {
    "/humanResourceReports" {
        controller = "reporting"
    }
}
```

It is best practice to be explicit about the fact that the controller is being provided by a plugin.

8.5 Interceptors

Grails provides standalone Interceptors using the [create-interceptor](#) command:

```
$ grails create-interceptor MyInterceptor
```

The above command will create an Interceptor in the `grails-app/controllers` directory with the f

```
class MyInterceptor {
    boolean before() { true }
    boolean after() { true }
    void afterView() {
        // no-op
    }
}
```

Interceptors vs Filters

In versions of Grails prior to Grails 3.0, Grails supported the notion of filters. These are still supported but deprecated.

The new interceptors concept in Grails 3.0 is superior in a number of ways, most significantly in its ability to be annotated to optimize performance (something which is often critical as interceptors can be executed for every request to the actions of the `BookController` will trigger the interceptor.

8.5.1 Defining Interceptors

By default interceptors will match the controllers with the same name. For example if you have an interceptor `BookControllerInterceptor`, all requests to the actions of the `BookController` will trigger the interceptor.

An [Interceptor](#) implements the [Interceptor](#) trait and provides 3 methods that can be used to intercept r

```
/**
 * Executed before a matched action
 *
 * @return Whether the action should continue and execute
 */
boolean before() { true }

/**
 * Executed after the action executes but prior to view rendering
 *
 * @return True if view rendering should continue, false otherwise
 */
boolean after() { true }

/**
 * Executed after view rendering completes
 */
void afterView() {}
```

As described above the `before` method is executed prior to an action and can cancel the execution of the

The `after` method is executed after an action executes and can halt view rendering if it returns false. The `afterView` method is executed after view rendering completes and can modify the `view` and `model` properties respectively:

```
boolean after() {
    model.foo = "bar" // add a new model attribute called 'foo'
    view = 'alternate' // render a different view called 'alternate'
    true
}
```

The `afterView` method is executed after view rendering completes. If an exception occurs, the exception is caught by the [Interceptor](#) trait.

8.5.2 Matching Requests with Intceptors

As mentioned in the previous section, by default an interceptor will match only requests to the associated controller. To configure the interceptor to match any request using the `match` or `matchAll` methods defined in the [Int](#)

The matching methods return a [Matcher](#) instance which can be used to configure how the interceptor matches

For example the following interceptor will match all requests except those to the `login` controller:

```

class AuthInterceptor {
    AuthInterceptor() {
        matchAll()
        .excludes(controller:"login")
    }
    boolean before() {
        // perform authentication
    }
}

```

You can also perform matching using named argument:

```

class LoggingInterceptor {
    LoggingInterceptor() {
        match(controller:"book", action:"show") // using strings
        match(controller: ~/(author|publisher)/) // using regex
    }
    boolean before() {
        ...
    }
}

```

You can use any number of matchers defined in your interceptor. They will be executed in the order in which the above interceptor will match for all of the following:

- when the show action of BookController is called
- when AuthorController or PublisherController is called

All named arguments except for `uri` accept either a String or a Regex expression. The `uri` argument is Spring's [AntPathMatcher](#). The possible named arguments are:

- `namespace` - The namespace of the controller
- `controller` - The name of the controller
- `action` - The name of the action
- `method` - The HTTP method
- `uri` - The URI of the request. If this argument is used then all other arguments will be ignored and only the `uri` argument will be used for matching.

8.5.3 Ordering Interceptor Execution

Interceptors can be ordered by defining an `order` property that defines a priority.

For example:

```
class AuthInterceptor {  
  int order = HIGHEST_PRECEDENCE  
  ...  
}
```

The default value of the `order` property is 0.

The values `HIGHEST_PRECEDENCE` and `LOWEST_PRECEDENCE` can be used to define filters that should

Note that if you write an interceptor that is to be used by others it is better to increment or decrement `LOWEST_PRECEDENCE` to allow other interceptors to be inserted before or after the interceptor you are at

```
int order = HIGHEST_PRECEDENCE + 50  
// or  
int order = LOWEST_PRECEDENCE - 50
```

To find out the computed order of interceptors you can add a debug logger to `logback.groovy` as follows

```
logger 'grails.artefact.Interceptor', DEBUG, ['STDOUT'], false
```

You can override any interceptors default order by using bean override configuration in `grails-app/conf`

```
beans:  
  authInterceptor:  
    order: 50
```

Or in `grails-app/conf/application.groovy`:

```
beans {
  authInterceptor {
    order = 50
  }
}
```

Thus giving you complete control over interceptor execution order. .

8.6 Content Negotiation

Grails has built in support for [Content negotiation](#) using either the HTTP Accept header, an explicit mapped URI.

Configuring Mime Types

Before you can start dealing with content negotiation you need to tell Grails what content types you wish with a number of different content types within `grails-app/conf/application.yml` using the g:

```
grails:
  mime:
    types:
      all: '*/*'
      atom: application/atom+xml
      css: text/css
      csv: text/csv
      form: application/x-www-form-urlencoded
      html:
        - text/html
        - application/xhtml+xml
      js: text/javascript
      json:
        - application/json
        - text/json
      multipartForm: multipart/form-data
      rss: application/rss+xml
      text: text/plain
      hal:
        - application/hal+json
        - application/hal+xml
      xml:
        - text/xml
        - application/xml
```

The setting can also be done in `grails-app/conf/application.groovy` as shown below:

```

grails.mime.types = [ // the first one is the default format
  all:                '/*/*', // 'all' maps to '*' or the first available format in w
  atom:               'application/atom+xml',
  css:                'text/css',
  csv:                'text/csv',
  form:               'application/x-www-form-urlencoded',
  html:               ['text/html', 'application/xhtml+xml'],
  js:                 'text/javascript',
  json:               ['application/json', 'text/json'],
  multipartForm:      'multipart/form-data',
  rss:                'application/rss+xml',
  text:               'text/plain',
  hal:                ['application/hal+json', 'application/hal+xml'],
  xml:                ['text/xml', 'application/xml']
]

```

The above bit of configuration allows Grails to detect to format of a request containing either the 'text/' or 'xml'. You can add your own types by simply adding new entries into the map. The first one is the default format.

Content Negotiation using the format Request Parameter

Let's say a controller action can return a resource in a variety of formats: HTML, XML, and JSON. What is a reliable way for the client to control this is through a `format` URL parameter.

So if you, as a browser or some other client, want a resource as XML, you can use a URL like this:

```
http://my.domain.org/books?format=xml
```

The result of this on the server side is a `format` property on the response object with the value `xml`.

You can also define this parameter in the [URL Mappings](#) definition:

```

"/book/list"(controller:"book", action:"list") {
  format = "xml"
}

```

You could code your controller action to return XML based on this property, but you can also make a helper method:

```

import grails.converters.JSON
import grails.converters.XML

class BookController {
  def list() {
    def books = Book.list()

    withFormat {
      html bookList: books
      json { render books as JSON }
      xml { render books as XML }
      '*' { render books as JSON }
    }
  }
}

```

In this example, Grails will only execute the block inside `withFormat()` that matches the requested content type. If no format matches, then Grails will execute the `html()` call only. Each 'block' can either be a map model for the corresponding view (for example) or a closure. The closure can contain any standard action code, for example it can return a model.

When no format matches explicitly, a **(wildcard) block can be used to handle all other formats.**

There is a special format, "all", that is handled differently from the explicit formats. If "all" is specified in the Accept header - see below), then the first block of `withFormat()` is executed when there isn't a (wildcard) block.

You should not add an explicit "all" block. In this example, a format of "all" will trigger the `html` handler (the first block).

```

withFormat {
  html bookList: books
  json { render books as JSON }
  xml { render books as XML }
}

```



When using [withFormat](#) make sure it is the last call in your controller action as the `render` method is used by the action to dictate what happens next.

Using the Accept header

Every incoming HTTP request has a special [Accept](#) header that defines what media types (or mime types) are typically:


```
* / *
```

which simply means anything. However, newer browsers send more interesting values such as this one sent

```
text/xml, application/xml, application/xhtml+xml, text/html;q=0.9,  
text/plain;q=0.8, image/png, */*;q=0.5
```

This particular accept header is unhelpful because it indicates that XML is the preferred response format. That's why Grails ignores the accept header by default for browsers. However, non-browser clients are typically able to send accept headers such as

```
application/json
```

As mentioned the default configuration in Grails is to ignore the accept header for browsers. `grails.mime.disable.accept.header.userAgents`, which is configured to detect the major browser user agents. This allows Grails' content negotiation to continue to work for non-browser clients:

```
grails.mime.disable.accept.header.userAgents = ['Gecko', 'WebKit', 'Presto', 'Trident']
```

For example, if it sees the accept header above ('application/json') it will set format to json as you can see with the `withFormat()` method in just the same way as when the format URL parameter is set (although the URL parameter takes precedence).

An accept header of `*/*` results in a value of `all` for the format property.



If the accept header is used but contains no registered content types, Grails will assume a text/html request and will set the HTML format - note that this is different from how the other content types would activate the "all" format!

Request format vs. Response format

As of Grails 2.0, there is a separate notion of the *request* format and the *response* format. The request format is typically used to detect if the incoming request can be parsed into XML or JSON, whilst the response format is used to attempt to deliver an appropriate response to the client.

The [withFormat](#) method available on controllers deals specifically with the response format. If you wish to add logic to do so using a separate `withFormat` method available on the request:

```
request.withFormat {  
    xml {  
        // read XML  
    }  
    json {  
        // read JSON  
    }  
}
```

Content Negotiation with URI Extensions

Grails also supports content negotiation using URI extensions. For example given the following URI:

```
/book/list.xml
```

This works as a result of the default URL Mapping definition which is:

```
"/$controller/$action?/$id?(.$format)?" {
```

Note the inclusion of the `format` variable in the path. If you do not wish to use content negotiation via the URL mapping:

```
"/$controller/$action?/$id?" {
```

Testing Content Negotiation

To test content negotiation in a unit or integration test (see the section on [Testing](#)) you can either manipula

```
void testJavascriptOutput() {
    def controller = new TestController()
    controller.request.addHeader "Accept",
        "text/javascript, text/html, application/xml, text/xml, */*"
    controller.testAction()
    assertEquals "alert('hello')", controller.response.contentAsString
}
```

Or you can set the format parameter to achieve a similar effect:

```
void testJavascriptOutput() {
    def controller = new TestController()
    controller.params.format = 'js'
    controller.testAction()
    assertEquals "alert('hello')", controller.response.contentAsString
}
```

9 Traits

Overview

Grails provides a number of traits which provide access to properties and behavior that may be accessed from Groovy classes which are part of a Grails project. Many of these traits are automatically added to Grails (for example) and are easy to add to other classes.

9.1 Traits Provided by Grails

Grails artefacts are automatically augmented with certain traits at compile time.

Domain Class Traits

- [grails.artefact.DomainClass](#)
- [grails.web.databinding.WebDataBinding](#)
- `org.grails.datastore.gorm.GormEntity`
- `org.grails.datastore.gorm.GormValidateable`

Controller Traits

- [grails.artefact.gsp.TagLibraryInvoker](#)
- [grails.artefact.AsyncController](#)
- [grails.artefact.controller.RestResponder](#)
- [grails.artefact.Controller](#)

Interceptor Trait

- [grails.artefact.Interceptor](#)

Tag Library Trait

- [grails.artefact.TagLibrary](#)

Service Trait

- [grails.artefact.Service](#)

Below is a list of other traits provided by the framework. The javadocs provide more detail about methods

Trait	Brief Description
grails.web.api.WebAttributes	Common Web Attributes
grails.web.api.ServletAttributes	Servlet API Attributes
grails.web.databinding.DataBinder	Data Binding API
grails.artefact.controller.support.RequestForwarder	Request Forwarding API
grails.artefact.controller.support.ResponseRedirector	Response Redirecting API
grails.artefact.controller.support.ResponseRenderer	Response Rendering API
grails.validation.Validateable	Validation API

9.1.1 WebAttributes Trait Example

[WebAttributes](#) is one of the traits provided by the framework. Any Groovy class may implement this trait provided by the trait.

```
// src/main/groovy/demo/Helper.groovy
package demo

import grails.web.api.WebAttributes

class Helper implements WebAttributes {

    List<String> getControllerNames() {
        // There is no need to pass grailsApplication as an argument
        // or otherwise inject the grailsApplication property. The
        // WebAttributes trait provides access to grailsApplication.
        grailsApplication.getArtefacts('Controller')*.name
    }
}
```

The traits are compatible with static compilation...

```
// src/main/groovy/demo/Helper.groovy
package demo

import grails.web.api.WebAttributes
import groovy.transform.CompileStatic

@CompileStatic
class Helper implements WebAttributes {

    List<String> getControllerNames() {
        // There is no need to pass grailsApplication as an argument
        // or otherwise inject the grailsApplication property. The
        // WebAttributes trait provides access to grailsApplication.
        grailsApplication.getArtefacts('Controller')*.name
    }
}
```

10 Web Services

Web Services are all about providing a web API onto your web application and are typically implemented

10.1 REST

REST is not really a technology in itself, but more an architectural pattern. REST is very simple and communication medium, combined with URL patterns that are "representational" of the underlying system and DELETE.

Each HTTP method maps to an action type. For example GET for retrieving data, POST for creating data,

Grails includes flexible features that make it easy to create RESTful APIs. Creating a RESTful resource is demonstrated in the next section.

10.1.1 Domain classes as REST resources

The easiest way to create a RESTful API in Grails is to expose a domain class as a REST resource. This is done by adding the `grails.rest.Resource` transformation to any domain class:

```
import grails.rest.*

@Resource(uri='/books')
class Book {

    String title

    static constraints = {
        title blank:false
    }
}
```

Simply by adding the `Resource` transformation and specifying a URI, your domain class will automatically be exposed as a RESTful resource. The transformation will automatically register the necessary [RESTful URIs](#) and create a `BookController`.

You can try it out by adding some test data to `Bootstrap.groovy`:

```
def init = { servletContext ->
    new Book(title:"The Stand").save()
    new Book(title:"The Shining").save()
}
```

And then hitting the URL `http://localhost:8080/books/1`, which will render the response like:

```
<?xml version="1.0" encoding="UTF-8"?>
<book id="1">
  <title>The Stand</title>
</book>
```

If you change the URL to `http://localhost:8080/books/1.json` you will get a JSON response:

```
{"id":1,"title":"The Stand"}
```

If you wish to change the default to return JSON instead of XML, you can do this by setting the `formats` property:

```
import grails.rest.*

@Resource(uri='/books', formats=['json', 'xml'])
class Book {
    ...
}
```

With the above example JSON will be prioritized. The list that is passed should contain the names of the formats that are defined in the `grails.mime.types` setting of `application.groovy`:

```
grails.mime.types = [
    ...
    json:          ['application/json', 'text/json'],
    ...
    xml:           ['text/xml', 'application/xml']
]
```

See the section on [Configuring Mime Types](#) in the user guide for more information.

Instead of using the file extension in the URI, you can also obtain a JSON response using the `ACCEPT` header:


```
$ curl -i -H "Accept: application/json" localhost:8080/books/1
{"id":1,"title":"The Stand"}
```

This works thanks to Grails' [Content Negotiation](#) features.

You can create a new resource by issuing a POST request:

```
$ curl -i -X POST -H "Content-Type: application/json" -d '{"title":"Along Came A S
HTTP/1.1 201 Created
Server: Apache-Coyote/1.1
...
```

Updating can be done with a PUT request:

```
$ curl -i -X PUT -H "Content-Type: application/json" -d '{"title":"Along Came A S
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
...
```

Finally a resource can be deleted with DELETE request:

```
$ curl -i -X DELETE localhost:8080/books/1
HTTP/1.1 204 No Content
Server: Apache-Coyote/1.1
...
```

As you can see, the Resource transformation enables all of the HTTP method verbs on the resource. setting the `readOnly` attribute to `true`:

```
import grails.rest.*

@Resource(uri='/books', readOnly=true)
class Book {
    ...
}
```

In this case POST, PUT and DELETE requests will be forbidden.

10.1.2 Mapping to REST resources

If you prefer to keep the declaration of the URL mapping in your `UrlMappings.groovy` file the Resource transformation and adding the following line to `UrlMappings.groovy` will suffice:

```
"/books"(resources:"book")
```

Extending your API to include more end points then becomes trivial:

```
"/books"(resources:"book") {
    "/publisher"(controller:"publisher", method:"GET")
}
```

The above example will expose the URI `/books/1/publisher`.

A more detailed explanation on [creating RESTful URL mappings](#) can be found in the [URL Mappings section](#)

10.1.3 Linking to REST resources from GSP pages

The `link` tag offers an easy way to link to any domain class resource:

```
<g:link resource="${book}">My Link</g:link>
```

However, currently you cannot use `g:link` to link to the DELETE action and most browsers do not support

The best way to accomplish this is to use a form submit:

```
<form action="/book/2" method="post">
  <input type="hidden" name="_method" value="DELETE"/>
</form>
```

Grails supports overriding the request method via the hidden `_method` parameter. This is for browser constrained resource mappings to create powerful web interfaces. To make a link fire this type of event, pass the `data-method` attribute and issue a form submit via javascript.

10.1.4 Versioning REST resources

A common requirement with a REST API is to expose different versions at the same time. There are a few

Versioning using the URI

A common approach is to use the URI to version APIs (although this approach is discouraged in favour of the following URL mappings:

```
"/books/v1"(resources:"book", namespace:'v1')
"/books/v2"(resources:"book", namespace:'v2')
```

That will match the following controllers:

```
package myapp.v1
class BookController {
    static namespace = 'v1'
}

package myapp.v2
class BookController {
    static namespace = 'v2'
}
```

This approach has the disadvantage of requiring two different URI namespaces for your API.

Versioning with the Accept-Version header

As an alternative Grails supports the passing of an `Accept-Version` header from clients. For example :

```
"/books"(version:'1.0', resources:"book", namespace:'v1')
"/books"(version:'2.0', resources:"book", namespace:'v2')
```

Then in the client simply pass which version you need using the `Accept-Version` header:

```
$ curl -i -H "Accept-Version: 1.0" -X GET http://localhost:8080/books
```

Versioning using Hypermedia / Mime Types

Another approach to versioning is to use Mime Type definitions to declare the version of your custom media. (see [RFC 2616](#) "Hypertext Transfer Protocol" for more information about Hypermedia concepts). For example, in `application/vnd.books.org.book+json` Mime Type for your resource that includes a version parameter (the 'v' parameter):

```
grails.mime.types = [
  all: '*/*',
  book: "application/vnd.books.org.book+json;v=1.0",
  bookv2: "application/vnd.books.org.book+json;v=2.0",
  ...
]
```



It is critical that place your new mime types after the 'all' Mime Type because if the Content-Type is established then the first entry in the map is used for the response. If you have your new Mime Type first, it will always try and send back your new Mime Type if the requested Mime Type cannot be established.

Then override the renderer (see the section on "Customizing Response Rendering" for more information) to use the new Mime Type in `grails-app/conf/spring/resources.groovy`:

```
import grails.rest.render.json.*
import grails.web.mime.*

beans = {
    bookRendererV1(JsonRenderer, myapp.v1.Book, new MimeType("application/vnd.booboo+json"))
    bookRendererV2(JsonRenderer, myapp.v2.Book, new MimeType("application/vnd.booboo+json"))
}
```

Then update the list of acceptable response formats in your controller:

```
class BookController extends RestfulController {
    static responseFormats = ['json', 'xml', 'book', 'bookv2']

    // ...
}
```

Then using the Accept header you can specify which version you need using the Mime Type:

```
$ curl -i -H "Accept: application/vnd.books.org.book+json;v=1.0" -X GET http://localhost:8080/book/1
```

10.1.5 Implementing REST controllers

The Resource transformation is a quick way to get started, but typically you'll want to customize the controller to extend the API to include additional actions.

10.1.5.1 Extending the RestfulController super class

The easiest way to get started doing so is to create a new controller for your resource that extends the `RestfulController` class. For example:

```
class BookController extends RestfulController {
    static responseFormats = ['json', 'xml']

    BookController() {
        super(Book)
    }
}
```

To customize any logic you can just override the appropriate action. The following table provides the nar to:

HTTP Method	URI	Controller Action
GET	/books	index
GET	/books/create	create
POST	/books	save
GET	/books/\${id}	show
GET	/books/\${id}/edit	edit
PUT	/books/\${id}	update
DELETE	/books/\${id}	delete



Note that the `create` and `edit` actions are only needed if the controller exposes an HTML i

As an example, if you have a [nested resource](#) then you would typically want to query both the parent a following URL mapping:

```
"/authors"(resources:'author') {  
  "/books"(resources:'book')  
}
```

You could implement the nested controller as follows:

```
class BookController extends RestfulController {  
  static responseFormats = ['json', 'xml']  
  BookController() {  
    super(Book)  
  }  
  
  @Override  
  protected Book queryForResource(Serializable id) {  
    Book.where {  
      id == id && author.id = params.authorId  
    }.find()  
  }  
}
```

The example above subclasses `RestController` and overrides the protected `queryForResource` resource to take into account the parent resource.

Customizing Data Binding In A RestfulController Subclass

The `RestController` class contains code which does data binding for actions like `save` and `update` method which returns a value which will be used as the source for data binding. For example, the `update` action

```
class RestfulController<T> {
  def update() {
    T instance = // retrieve instance from the database...
    instance.properties = getObjectToBind()
    // ...
  }
  // ...
}
```

By default the `getObjectToBind()` method returns the [request](#) object. When the request object is body then the body will be parsed and its contents will be used to do the data binding, otherwise the binding. Subclasses of `RestController` may override the `getObjectToBind()` method and return an [Map](#) or a [DataBindingSource](#). For most use cases binding the request is appropriate but the `getObjectToBind()` behavior where desired.

Using custom subclass of RestfulController with Resource annotation

You can also customize the behaviour of the controller that backs the `Resource` annotation.

The class must provide a constructor that takes a domain class as it's argument. The second constructor with `readOnly=true`.

This is a template that can be used for subclassed `RestController` classes used in `Resource` annotations:

```
class SubclassRestController<T> extends RestfulController<T> {
  SubclassRestController(Class<T> domainClass) {
    this(domainClass, false)
  }
  SubclassRestController(Class<T> domainClass, boolean readOnly) {
    super(domainClass, readOnly)
  }
}
```

You can specify the super class of the controller that backs the `Resource` annotation with the `superClass`

```
import grails.rest.*

@Resource(uri='/books', superClass=SubclassRestfulController)
class Book {

    String title

    static constraints = {
        title blank:false
    }
}
```

10.1.5.2 Implementing REST Controllers Step by Step

If you don't want to take advantage of the features provided by the `RestfulController` superclass yourself manually. The first step is to create a controller:

```
$ grails create-controller book
```

Then add some useful imports and enable `readOnly` by default:

```
import grails.transaction.*
import static org.springframework.http.HttpStatus.*
import static org.springframework.http.HttpMethod.*

@Transactional(readOnly = true)
class BookController {
    ...
}
```

Recall that each HTTP verb matches a particular Grails action according to the following conventions:

HTTP Method	URI	Controller Action
GET	/books	index
GET	/books/\${id}	show
GET	/books/create	create
GET	/books/\${id}/edit	edit
POST	/books	save
PUT	/books/\${id}	update
DELETE	/books/\${id}	delete



The 'create' and 'edit' actions are already required if you plan to implement an HTML interface. They are there in order to render appropriate HTML forms to create and edit a resource. If you are using REST, they can be discarded.

The key to implementing REST actions is the [respond](#) method introduced in Grails 2.3. The `respond` method returns a response for the requested content type (JSON, XML, HTML etc.)

Implementing the 'index' action

For example, to implement the `index` action, simply call the `respond` method passing the list of objects

```
def index(Integer max) {
    params.max = Math.min(max ?: 10, 100)
    respond Book.list(params), model:[bookCount: Book.count()]
}
```

Note that in the above example we also use the `model` argument of the `respond` method to supply the support pagination via some user interface.

The `respond` method will, using [Content Negotiation](#), attempt to reply with the most appropriate response (via the `ACCEPT` header or file extension).

If the content type is established to be HTML then a model will be produced such that the action above would

```
def index(Integer max) {
    params.max = Math.min(max ?: 10, 100)
    [bookList: Book.list(params), bookCount: Book.count()]
}
```

By providing an `index.gsp` file you can render an appropriate view for the given model. If the `content.respond` method will attempt to lookup an appropriate `grails.rest.render.Renderer` instance. This is done by inspecting the `grails.rest.render.RendererRegistry`.

By default there are already renderers configured for JSON and XML, to find out how to register a custom `Response Rendering`".

Implementing the 'show' action

The `show` action, which is used to display an individual resource by id, can be implemented in the following signature):

```
def show(Book book) {
    respond book
}
```

By specifying the domain instance as a parameter to the action Grails will automatically attempt to lookup the request. If the domain instance doesn't exist, then `null` will be passed into the action. The `respond` method will otherwise once again attempt to render an appropriate response. If the format is HTML then an action is functionally equivalent to the above action:

```
def show(Book book) {
    if(book == null) {
        render status:404
    }
    else {
        return [book: book]
    }
}
```

Implementing the 'save' action

The `save` action creates new resource representations. To start off, simply define an action that accepts `Transactional` with the `grails.transaction.Transactional` transform:

```
@Transactional
def save(Book book) {
    ...
}
```

Then the first thing to do is check whether the resource has any [validation errors](#) and if so respond with the

```
if(book.hasErrors()) {
    respond book.errors, view:'create'
}
else {
    ...
}
```

In the case of HTML the 'create' view will be rendered again so the user can correct the invalid input. In the errors object itself will be rendered in the appropriate format and a status code of 422 (UNPROCESSABLE ENTITY).

If there are no errors then the resource can be saved and an appropriate response sent:

```
book.save flush:true
withFormat {
    html {
        flash.message = message(code: 'default.created.message', args: [message(
'Book'), book.id])
        redirect book
    }
    '*' { render status: CREATED }
}
```

In the case of HTML a redirect is issued to the originating resource and for other formats a status code of 201 (CREATED) is returned.

Implementing the 'update' action

The update action updates an existing resource representations and is largely similar to the save action.

```
@Transactional
def update(Book book) {
    ...
}
```

If the resource exists then Grails will load the resource, otherwise null we passed. In the case of null, you should respond with a 404 (NOT FOUND).

```

if(book == null) {
    render status: NOT_FOUND
}
else {
    ...
}

```

Then once again check for errors [validation errors](#) and if so respond with the errors:

```

if(book.hasErrors()) {
    respond book.errors, view:'edit'
}
else {
    ...
}

```

In the case of HTML the 'edit' view will be rendered again so the user can correct the invalid input. In the errors object itself will be rendered in the appropriate format and a status code of 422 (UNPROCESSABLE ENTITY).

If there are no errors then the resource can be saved and an appropriate response sent:

```

book.save flush:true
withFormat {
    html {
        flash.message = message(code: 'default.updated.message', args: [message(code: 'Book'), book.id])
        redirect book
    }
    '*' { render status: OK }
}

```

In the case of HTML a redirect is issued to the originating resource and for other formats a status code of 200 is returned.

Implementing the 'delete' action

The delete action deletes an existing resource. The implementation is largely similar to the update action instead:

```

book.delete flush:true
withFormat {
  html {
    flash.message = message(code: 'default.deleted.message', args: [message(c
    'Book'), book.id])
    redirect action:"index", method:"GET"
  }
  '*' { render status: NO_CONTENT }
}

```

Notice that for an HTML response a redirect is issued back to the `index` action, whilst for other content returned.

10.1.5.3 Generating a REST controller using scaffolding

To see some of these concepts in action and help you get going the [Scaffolding plugin](#), version 2.0 and a you, simply run the command:

```
$ grails generate-controller [Domain Class Name]
```

10.1.6 The REST Profile

Since Grails 3.1, Grails supports a tailored profile for creating REST applications that provides a more focus. To get started with the REST profile create an application with by specifying `rest-api` as the name of the profile.

```
$ grails create-app my-api --profile rest-api
```

This will create a new REST application that provides the following features:

- Default set of commands for creating and generating REST endpoints
- Defaults to using JSON views for rendering responses (see the next section)
- Few plugins than the default Grails plugin (no GSP, no Asset Pipeline, Nothing HTML related)

You will notice for example in the `grails-app/views` directory that there are `*.json` files for rendering 404 and 500 errors.

If you issue the following set of commands:

```
$ grails create-domain-class book
$ grails generate-all my.api.Book
```

Instead of CRUD HTML interface a REST endpoint is generated that produces JSON responses. In add default test the REST endpoint.

10.1.7 The Angular Profile

Since Grails 3.1, Grails supports a profile for creating applications with AngularJS that provides a more fi angular profile inherits from the REST profile and therefore has all of the commands and properties that th

To get started with the Angular profile create an application with by specifying `angular` as the name of t

```
$ grails create-app my-api --profile angular
```

This will create a new Grails application that provides the following features:

- Default set of commands for creating Angular artefacts
- Gradle plugin to manage client side dependencies
- Gradle plugin to execute client side unit tests
- Asset Pipeline plugins to ease development

By default the Angular profile includes GSP support in order to render the index page. This is necessa pipeline.

The new commands are:

- `create-ng-component`
- `create-ng-controller`
- `create-ng-directive`
- `create-ng-domain`
- `create-ng-module`
- `create-ng-service`

Project structure

The Angular profile is designed around a specific project structure. The `create-ng` commands will exist.

Example:

```
$ grails create-ng-controller foo
```

This will produce a `fooController.js` file in `grails-app/assets/javascripts/${default}`



By default the angular profile will create files in the `javascripts` directory. You can configuration with the key `grails.codegen.angular.assetDir`.

```
$ grails create-ng-domain foo.bar
```

This will produce a `Bar.js` file in `grails-app/assets/javascripts/foo/domains`. It will already exist.

```
$ grails create-ng-module foo.bar
```

This will produce a `foo.bar.js` file in `grails-app/assets/javascripts/foo/bar`. Note that other artefacts.

```
$ grails create-ng-service foo.bar --type constant
```

This will produce a `bar.js` file in `grails-app/assets/javascripts/foo/services`. It will already exist. The `create-ng-service` command accepts a flag `-type`. The types that can be used are

- service
- factory *default*
- value
- provider
- constant

Along with the artefacts themselves, the profile will also produce a skeleton unit test file under `src/test`

Client side dependencies

The [Gradle Bower Plugin](#) is used to manage dependencies with bower. Visit the plugin documentation to learn

Unit Testing

The [Gradle Karma Plugin](#) is used to execute client side unit tests. All generated tests are written with JUnit, see [how to use the plugin](#).

Asset Pipeline

The Angular profile includes several asset pipeline plugins to make development easier.

- [JS Closure Wrap Asset Pipeline](#) will wrap your Angular code in immediately invoked function expressions
- [Annotate Asset Pipeline](#) will annotate your dependencies to be safe for minification.
- [Template Asset Pipeline](#) will put your templates into the `$templateCache` to prevent http requests

10.1.8 JSON Views

As mentioned in the previous section the REST profile by default uses JSON views to render JSON responses instead of HTML. Instead, JSON responses are optimized for outputting JSON responses instead of HTML.

You can continue to separate your application in terms of MVC, with the logic of your application residing in controllers and views. JSON matters are handled by JSON views.

JSON views also provide the flexibility to easily customize the JSON presented to clients without having to use external libraries like Jackson or Grails' marshaller API.



Since Grails 3.1, JSON views are considered by the Grails team the best way to present JSON. That's the reason the section on writing custom marshallers has been removed from the user guide. For more information on that topic, see [the Grails 3.0.x guide](#).

10.1.8.1 Getting Started

If you are using the REST or AngularJS profiles then the JSON views plugin will already be included in your dependencies. Otherwise you will need to modify your `build.gradle` to include the necessary plugin to activate JSON views.


```
compile 'org.grails.plugins:views-json:1.0.0' // or whatever is the latest version
```



Tip: The [source code repository for JSON views](#) can be found on Github if you are looking for contributions

In order to compile JSON views for production deployment you should also activate the Gradle plugin by t

```
buildscript {
    ...
    dependencies {
        ...
        classpath "org.grails.plugins:views-gradle:1.0.0"
    }
}
```

Then apply the `org.grails.plugins.views-json` Gradle plugin after any Grails core gradle plug

```
...
apply plugin: "org.grails.grails-web"
apply plugin: "org.grails.plugins.views-json"
```

This will add a `compileGsonViews` task to Gradle, which is invoked prior to creating the production JAR

10.1.8.2 Creating JSON Views

JSON views go into the `grails-app/views` directory and end with the `.json` suffix. They are rendered by the Groovy editor.

Example JSON view:

```
json.person {  
    name "bob"  
}
```



Tip: To open them in the Groovy editor in IntelliJ double click on the file and when asked v choose "Groovy"

The above JSON view produces:

```
{ "person": { "name": "bob" } }
```

There is an implicit `json` variable which is an instance of [StreamingJsonBuilder](#).

Example usages:

```
json(1,2,3) == "[1,2,3]"  
json { name "Bob" } == '{ "name": "Bob" }'  
json([1,2,3]) { n it } == '[ { "n": 1 }, { "n": 2 }, { "n": 3 } ]'
```

Refer to the API documentation on [StreamingJsonBuilder](#) for more information about what is possible.

10.1.8.3 JSON View Templates

You can define templates starting with underscore `_`. For example given the following template called `_pe`

```
model {  
    Person person  
}  
json {  
    name person.name  
    age person.age  
}
```

You can render it with a view as follows:

```
model {
  Family family
}
json {
  name family.father.name
  age family.father.age
  oldestChild g.render(template:"person", model:[person: family.children.max {
  children g.render(template:"person", collection: family.children, var:'person
}
```

Alternatively for a more concise way to invoke templates, using the `tmpl` variable:

```
model {
  Family family
}
json {
  name family.father.name
  age family.father.age
  oldestChild tmpl.person( family.children.max { Person p -> p.age } ] )
  children tmpl.person( family.children )
}
```

10.1.8.4 Rendering Domain Classes with JSON Views

Typically your model may involve one or many domain instances. JSON views provide a render method for

For example given the following domain class:

```
class Book {
  String title
}
```

And the following template:

```
model {  
  Book book  
}  
  
json g.render(book)
```

The resulting output is:

```
{id:1,"title":"The Stand"}
```

You can customize the rendering by including or excluding properties:

```
json g.render(book, [includes:['title']])
```

Or by providing a closure to add additional JSON output:

```
json g.render(book) {  
  pages 1000  
}
```

10.1.8.5 JSON Views by Convention

There are a few useful conventions you can follow when creating JSON views. For example if you have a template located at `grails-app/views/book/_book.gson` and using the [respond](#) method will result in the following JSON output:

```
def show(Long id) {  
  respond Book.get(id)  
}
```

In addition if an error occurs during validation by default Grails will try to render a template called `grails-app/views/errors/_errors.gson` otherwise it will try to render `grails-app/views/errors/_errors.gson` if the former doesn't exist. This is useful because when persisting objects you can respond with validation errors to render these af

```
@Transactional
def save(Book book) {
    if (book.hasErrors()) {
        transactionStatus.setRollbackOnly()
        respond book.errors
    }
    else {
        // valid object
    }
}
```

If a validation error occurs in the above example the `grails-app/views/book/_errors.gson` template will be rendered. For more information on JSON views (and Markup views), see the [README and documentation included](#)

10.1.9 Customizing Response Rendering

If you are looking for a more low-level API and JSON or Markup views don't suite your needs then you can use the `GrailsResponseRenderer` interface.

10.1.9.1 Customizing the Default Renderers

The default renderers for XML and JSON can be found in the `grails.rest.render.xml` and `grails.rest.render.json` respectively. These use the Grails converters (`grails.converters.XML` and `grails.converters.JSON`).

You can easily customize response rendering using these default renderers. A common change you may want to make is to exclude certain properties from rendering.

Including or Excluding Properties from Rendering

As mentioned previously, Grails maintains a registry of `grails.rest.render.Renderer` instances and the ability to register or override renderers for a given domain class or even for a collection of domain classes. When customizing response rendering you need to register a custom renderer by defining a bean in `grails-app/conf/spring/r`

```
import grails.rest.render.xml.*

beans = {
    bookRenderer(XmlRenderer, Book) {
        includes = ['title']
    }
}
```



The bean name is not important (Grails will scan the application context for all registered beans). For organizational and readability purposes it is recommended you name it something meaningful.

To exclude a property, the `excludes` property of the `XmlRenderer` class can be used:

```
import grails.rest.render.xml.*

beans = {
    bookRenderer(XmlRenderer, Book) {
        excludes = ['isbn']
    }
}
```

Customizing the Converters

As mentioned previously, the default renders use the `grails.converters` package under the covers. To do the following:

```
import grails.converters.*

...
render book as XML
// or render book as JSON
```

Why the separation between converters and renderers? Well a renderer has more flexibility to use when implementing a custom renderer you could use [Jackson](#), [Gson](#) or any Java library to implement the rendering tied to Grails' own marshalling implementation.

10.1.9.2 Implementing a Custom Renderer

If you want even more control of the rendering or prefer to use your own marshalling techniques then you can. For example below is a simple implementation that customizes the rendering of the `Book` class:

```

package myapp
import grails.rest.render.*
import grails.web.mime.MimeType

class BookXmlRenderer extends AbstractRenderer<Book> {
    BookXmlRenderer() {
        super(Book, [MimeType.XML,MimeType.TEXT_XML] as MimeType[])
    }

    void render(Book object, RenderContext context) {
        context.contentType = MimeType.XML.name

        def xml = new groovy.xml.MarkupBuilder(context.writer)
        xml.book(id: object.id, title:object.title)
    }
}

```

The AbstractRenderer super class has a constructor that takes the class that it renders and the Mime header or file extension) for the renderer.

To configure this renderer, simply add it is a bean to `grails-app/conf/spring/resources.groovy`

```

beans = {
    bookRenderer(myapp.BookXmlRenderer)
}

```

The result will be that all Book instances will be rendered in the following format:

```
<book id="1" title="The Stand"/>
```



Note that if you change the rendering to a completely different format like the above, then binding if you plan to support POST and PUT requests. Grails will not automatically know how to render XML format to a domain class otherwise. See the section on "Customizing Binding of Resources".

Container Renderers

A `grails.rest.render.ContainerRenderer` is a renderer that renders responses for container objects. Its interface is largely the same as the `Renderer` interface except for the addition of the `getComponentType()` "contained" type. For example:

```

class BookListRendererer implements ContainerRendererer<List, Book> {
    Class<List> getTargetType() { List }
    Class<Book> getComponentType() { Book }
    MimeType[] getMimeTypes() { [ MimeType.XML] as MimeType[] }
    void render(List object, RenderContext context) {
        ....
    }
}

```

10.1.9.3 Using GSP to Customize Rendering

You can also customize rendering on a per action basis using Groovy Server Pages (GSP). For example given

```

def show(Book book) {
    respond book
}

```

You could supply a `show.xml.gsp` file to customize the rendering of the XML:

```

<%@page contentType="application/xml"%>
<book id="${book.id}" title="${book.title}"/>

```

10.1.10 Hypermedia as the Engine of Application State

[HATEOAS](#), an abbreviation for Hypermedia as the Engine of Application State, is a common pattern applied to REST APIs and linking to define the REST API.

Hypermedia (also called Mime or Media Types) are used to describe the state of a REST resource, and link to other resources. The format of the response is typically JSON or XML, although standard formats such as [Atom](#) and/or [HAL](#) are also used.

10.1.10.1 HAL Support

[HAL](#) is a standard exchange format commonly used when developing REST APIs that follow HATEOAS. An example of representing a list of orders can be seen below:


```

{
  "_links": {
    "self": { "href": "/orders" },
    "next": { "href": "/orders?page=2" },
    "find": {
      "href": "/orders/{id}",
      "templated": true
    },
    "admin": [{
      "href": "/admins/2",
      "title": "Fred"
    }, {
      "href": "/admins/5",
      "title": "Kate"
    }]
  },
  "currentlyProcessing": 14,
  "shippedToday": 20,
  "_embedded": {
    "order": [{
      "_links": {
        "self": { "href": "/orders/123" },
        "basket": { "href": "/baskets/98712" },
        "customer": { "href": "/customers/7809" }
      },
      "total": 30.00,
      "currency": "USD",
      "status": "shipped"
    }, {
      "_links": {
        "self": { "href": "/orders/124" },
        "basket": { "href": "/baskets/97213" },
        "customer": { "href": "/customers/12369" }
      },
      "total": 20.00,
      "currency": "USD",
      "status": "processing"
    }]
  }
}

```

Exposing Resources Using HAL

To return HAL instead of regular JSON for a resource you can simply override the renderer in `grails-rest` with an instance of `grails.rest.render.hal.HalJsonRenderer` (or `HalXmlRenderer` for t

```

import grails.rest.render.hal.*
beans = {
    halBookRenderer(HalJsonRenderer, rest.test.Book)
}

```

With the bean in place requesting the HAL content type will return HAL:

```
$ curl -i -H "Accept: application/hal+json" http://localhost:8080/books/1
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/hal+json;charset=ISO-8859-1

{
  "_links": {
    "self": {
      "href": "http://localhost:8080/books/1",
      "hreflang": "en",
      "type": "application/hal+json"
    }
  },
  "title": "The Stand"
}
```

To use HAL XML format simply change the renderer:

```
import grails.rest.render.hal.*
beans = {
    halBookRenderer(HalXmlRenderer, rest.test.Book)
}
```

Rendering Collections Using HAL

To return HAL instead of regular JSON for a list of resources you can grails-app/conf/spring/resources.groovy with an instance of grails.rest.render.

```
import grails.rest.render.hal.*
beans = {
    halBookCollectionRenderer(HalJsonCollectionRenderer, rest.test.Book)
}
```

With the bean in place requesting the HAL content type will return HAL:

```
$ curl -i -H "Accept: application/hal+json" http://localhost:8080/books
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/hal+json;charset=UTF-8
Transfer-Encoding: chunked
Date: Thu, 17 Oct 2013 02:34:14 GMT
```

```
{
  "_links": {
    "self": {
      "href": "http://localhost:8080/books",
      "hreflang": "en",
      "type": "application/hal+json"
    }
  },
  "_embedded": {
    "book": [
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/books/1",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "The Stand"
      },
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/books/2",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "Infinite Jest"
      },
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/books/3",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "Walden"
      }
    ]
  }
}
```

Notice that the key associated with the list of Book objects in the rendered JSON is `book` which is derived from the `Book` bean. In order to customize the value of this key assign a value to the `collectionName` property of the `Book` bean as shown below:

```
import grails.rest.render.hal.*
beans = {
    halBookCollectionRenderer(HalCollectionJsonRenderer, rest.test.Book) {
        collectionName = 'publications'
    }
}
```

With that in place the rendered HAL will look like the following:

```
$ curl -i -H "Accept: application/hal+json" http://localhost:8080/books
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/hal+json;charset=UTF-8
Transfer-Encoding: chunked
Date: Thu, 17 Oct 2013 02:34:14 GMT
```

```
{
  "_links": {
    "self": {
      "href": "http://localhost:8080/books",
      "hreflang": "en",
      "type": "application/hal+json"
    }
  },
  "_embedded": {
    "publications": [
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/books/1",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "The Stand"
      },
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/books/2",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "Infinite Jest"
      },
      {
        "_links": {
          "self": {
            "href": "http://localhost:8080/books/3",
            "hreflang": "en",
            "type": "application/hal+json"
          }
        },
        "title": "Walden"
      }
    ]
  }
}
```

Using Custom Media / Mime Types

If you wish to use a custom Mime Type then you first need to declare the Mime Types in `grails-app/`

```
grails.mime.types = [
    all:      "**/*",
    book:     "application/vnd.books.org.book+json",
    bookList: "application/vnd.books.org.booklist+json",
    ...
]
```



It is critical that place your new mime types after the 'all' Mime Type because if the Content Type is established then the first entry in the map is used for the response. If you have your new Mime Type before the 'all' entry, it will always try and send back your new Mime Type if the requested Mime Type cannot be established.

Then override the renderer to return HAL using the custom Mime Types:

```
import grails.rest.render.hal.*
import grails.web.mime.*

beans = {
    halBookRenderer(HalJsonRenderer, rest.test.Book, new MimeType("application/vnd.books.org.book+json"))
    halBookListRenderer(HalJsonCollectionRenderer, rest.test.Book, new MimeType("application/vnd.books.org.booklist+json", [v:"1.0"]))
}
```

In the above example the first bean defines a HAL renderer for a single book in application/vnd.books.org.book+json. The second bean defines the Mime Type used to render a list of books (application/vnd.books.org.booklist+json).



application/vnd.books.org.booklist+json is an example of a media-range value (http://www.w3.org/Protocols/rfc2616/rfc2616.html - Header Field Definitions). This example operation (list) to form the media-range values but in reality, it may not be necessary to create a new Mime Type for each operation. Further, it may not be necessary to create Mime types at the entity level. See "Defining REST resources" for further information about how to define your own Mime types.

With this in place issuing a request for the new Mime Type returns the necessary HAL:

```
$ curl -i -H "Accept: application/vnd.books.org.book+json" http://localhost:8080/
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/vnd.books.org.book+json;charset=ISO-8859-1

{
  "_links": {
    "self": {
      "href": "http://localhost:8080/books/1",
      "hreflang": "en",
      "type": "application/vnd.books.org.book+json"
    }
  },
  "title": "The Stand"
}
```

Customizing Link Rendering

An important aspect of HATEOAS is the usage of links that describe the transitions the client can use. `HalJsonRenderer` will automatically create links for you for associations and to the resource itself (using `book.links`).

However you can customize link rendering using the `link` method that is added to all domain classes and to any class annotated with `grails.rest.Linkable`. For example, the `show` action can be modified and the output:

```
def show(Book book) {
    book.link rel: 'publisher', href: g.createLink(absolute: true, resource: "publisher")
    respond book
}
```

Which will result in output such as:

```

{
  "_links": {
    "self": {
      "href": "http://localhost:8080/books/1",
      "hreflang": "en",
      "type": "application/vnd.books.org.book+json"
    }
  },
  "publisher": {
    "href": "http://localhost:8080/books/1/publisher",
    "hreflang": "en"
  },
  "title": "The Stand"
}

```

The `link` method can be passed named arguments that match the properties of the `grails.rest.Link`

10.1.10.2 Atom Support

[Atom](#) is another standard interchange format used to implement REST APIs. An example of Atom output is

```

<?xml version="1.0" encoding="utf-8"?>
<feed xmlns="http://www.w3.org/2005/Atom">

<title>Example Feed</title>
<link href="http://example.org/" />
<updated>2003-12-13T18:30:02Z</updated>
<author>
  <name>John Doe</name>
</author>
<id>urn:uuid:60a76c80-d399-11d9-b93C-0003939e0af6</id>

<entry>
  <title>Atom-Powered Robots Run Amok</title>
  <link href="http://example.org/2003/12/13/atom03" />
  <id>urn:uuid:1225c695-cfb8-4ebb-aaaa-80da344efa6a</id>
  <updated>2003-12-13T18:30:02Z</updated>
  <summary>Some text.</summary>
</entry>

</feed>

```

To use Atom rendering again simply define a custom renderer:


```
import grails.rest.render.atom.*
beans = {
    halBookRenderer(AtomRenderer, rest.test.Book)
    halBookListRenderer(AtomCollectionRenderer, rest.test.Book)
}
```

10.1.10.3 Vnd.Error Support

[Vnd.Error](#) is a standardised way of expressing an error response.

By default when a validation error occurs when attempting to POST new resources then the errors object w

```
$ curl -i -H "Accept: application/json" -H "Content-Type: application/json" -X P
http://localhost:8080/books

HTTP/1.1 422 Unprocessable Entity
Server: Apache-Coyote/1.1
Content-Type: application/json;charset=ISO-8859-1

{"errors":[{"object":"rest.test.Book", "field":"title", "rejected-value":null, "m
[class rest.test.Book] cannot be null"}]}
```

If you wish to change the format to Vnd.Error then simply register `grails.rest.render.er`
`grails-app/conf/spring/resources.groovy`:

```
beans = {
    vndJsonErrorRenderer(grails.rest.render.errors.VndErrorJsonRenderer)
    // for Vnd.Error XML format
    vndXmlErrorRenderer(grails.rest.render.errors.VndErrorXmlRenderer)
}
```

Then if you alter the client request to accept Vnd.Error you get an appropriate response:

```
$ curl -i -H "Accept: application/vnd.error+json,application/json" -H "Content-Type: application/json" http://localhost:8080/books
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/vnd.error+json;charset=ISO-8859-1

[
  {
    "logref": "\"book.nullable\"",
    "message": "Property [title] of class [class rest.test.Book] cannot be null",
    "_links": {
      "resource": {
        "href": "http://localhost:8080/rest-test/books"
      }
    }
  }
]
```

10.1.11 Customizing Binding of Resources

The framework provides a sophisticated but simple mechanism for binding REST requests to domain classes. The advantage of this is to bind the request property in a controller to the properties of a domain class. For example, if the createBook action will create a new Book and assign "The Stand" to the title property.

```
<?xml version="1.0" encoding="UTF-8"?>
<book>
  <title>The Stand</title>
  <authorName>Stephen King</authorName>
</book>
```

```
class BookController {
  def createBook() {
    def book = new Book()
    book.properties = request

    // ...
  }
}
```

Command objects will automatically be bound with the body of the request:

```

class BookController {
    def createBook(BookCommand book) {

        // ...
    }
}

class BookCommand {
    String title
    String authorName
}

```

If the command object type is a domain class and the root element of the XML document contains an id, the corresponding persistent instance from the database will be found and then the rest of the document will be bound. If not found in the database, the command object reference will be null.

```

<?xml version="1.0" encoding="UTF-8"?>
<book id="42">
    <title>Walden</title>
    <authorName>Henry David Thoreau</authorName>
</book>

```

```

class BookController {
    def updateBook(Book book) {
        // The book will have been retrieved from the database and updated
        // by doing something like this:
        //
        // book == Book.get('42')
        // if(book != null) {
        //     book.properties = request
        // }
        //
        // the code above represents what the framework will
        // have done. There is no need to write that code.

        // ...
    }
}

```

The data binding depends on an instance of the [DataBindingSource](#) interface created by an instance of a specific implementation of DataBindingSourceCreator will be selected based on the contentType provided to handle common content types. The default implementations will be fine for most use cases. They are supported by the core framework and which DataBindingSourceCreator implementations are in the org.grails.databinding.bindingsource package.

Content Type(s)	Bean Name	DataBindingSourceCreator Impl.
application/xml, text/xml	xmlDataBindingSourceCreator	XmlDataBindingSourceCreator
application/json, text/json	jsonDataBindingSourceCreator	JsonDataBindingSourceCreator
application/hal+json	halJsonDataBindingSourceCreator	HalJsonDataBindingSourceCreator
application/hal+xml	halXmlDataBindingSourceCreator	HalXmlDataBindingSourceCreator

In order to provide your own `DataBindingSourceCreator` for any of those content `DataBindingSourceCreator` and register an instance of that class in the Spring application context. use the corresponding bean name from above. If you are providing a helper for a content type other than bean name may be anything that you like but you should take care not to conflict with one of the bean nam

The `DataBindingSourceCreator` interface defines just 2 methods:

```
package org.grails.databinding.bindingsource

import grails.web.mime.MimeType
import grails.databinding.DataBindingSource

/**
 * A factory for DataBindingSource instances
 *
 * @since 2.3
 * @see DataBindingSourceRegistry
 * @see DataBindingSource
 */
interface DataBindingSourceCreator {

    /**
     * return All of the {link MimeType} supported by this helper
     */
    MimeType[] getMimeType()

    /**
     * Creates a DataBindingSource suitable for binding bindingSource to bindingTa
     *
     * @param mimeType a mime type
     * @param bindingTarget the target of the data binding
     * @param bindingSource the value being bound
     * @return a DataBindingSource
     */
    DataBindingSource createDataBindingSource(MimeType mimeType, Object bindingTa
}
```

[AbstractRequestBodyDataBindingSourceCreator](#) is an abstract class designed to be e `DataBindingSourceCreator` classes. Classes which extend `AbstractRequestbodyDataabin` method named `createBindingSource` which accepts an `InputStream` as an argument and : implementing the `getMimeType` method described in the `DataBindingSourceCreator` interl `createBindingSource` provides access to the body of the request.

The code below shows a simple implementation.

```

// MyCustomDataBindingSourceCreator.groovy in
// src/groovy/com/demo/myapp/databinding
package com.demo.myapp.databinding

import grails.web.mime.MimeType
import grails.databinding.DataBindingSource
import org...databinding.SimpleMapDataBindingSource
import org...databinding.bindingsource.AbstractRequestBodyDataBindingSourceCreator

/**
 * A custom DataBindingSourceCreator capable of parsing key value pairs out of
 * a request body containing a comma separated list of key:value pairs like:
 *
 * name:Herman,age:99,town:STL
 */
class MyCustomDataBindingSourceCreator extends AbstractRequestBodyDataBindingSourceCreator

@Override
public MimeType[] getMimeTypeTypes() {
    [new MimeType('text/custom+demo+csv')] as MimeType[]
}

@Override
protected DataBindingSource createBindingSource(InputStream inputStream) {
    def map = [:]

    def reader = new InputStreamReader(inputStream)

    // this is an obviously naive parser and is intended
    // for demonstration purposes only.
    reader.eachLine { line ->
        def keyValuePairs = line.split(',')
        keyValuePairs.each { keyValuePair ->
            if(keyValuePair?.trim()) {
                def keyValuePieces = keyValuePair.split(':')
                def key = keyValuePieces[0].trim()
                def value = keyValuePieces[1].trim()
                map[key] = value
            }
        }
    }

    // create and return a DataBindingSource which contains the parsed data
    new SimpleMapDataBindingSource(map)
}

```

An instance of MyCustomDataBindingSourceCreator needs to be registered in the spring application context

```

// grails-app/conf/spring/resources.groovy
beans = {

    myCustomCreator com.demo.myapp.databinding.MyCustomDataBindingSourceCreator

    // ...
}

```

With that in place the framework will use the myCustomCreator bean any time a DataBindingSource which has a contentType of "text/custom+demo+csv".

10.2 RSS and Atom

No direct support is provided for RSS or Atom within Grails. You could construct RSS or ATOM feeds yourself, but there is however a [Feeds plugin](#) available for Grails that provides a RSS and Atom builder using the popular JFeed API. See the code seen below:

```
def feed() {
    render(feedType: "rss", feedVersion: "2.0") {
        title = "My test feed"
        link = "http://your.test.server/yourController/feed"

        for (article in Article.list()) {
            entry(article.title) {
                link = "http://your.test.server/article/${article.id}"
                article.content // return the content
            }
        }
    }
}
```

11 Asynchronous Programming

With modern hardware featuring multiple cores, many programming languages have been adding asynchronous programming, being no exception.

The excellent [GPars](#) project features a whole range of different APIs for asynchronous programming techniques like flow concurrency.

Added Grails 2.3, the Async features of Grails aim to simplify concurrent programming within the framework's unified event model.

11.1 Promises

A Promise is a concept being embraced by many concurrency frameworks. They are similar to `java.util.concurrent.Future`. They include a more user friendly exception handling model, useful features like chaining and the ability to attach callbacks.

Promise Basics

In Grails the `grails.async.Promises` class provides the entry point to the Promise API:

```
import static grails.async.Promises.*
```

To create promises you can use the `task` method, which returns an instance of the `grails.async.Promise` class:

```
def p1 = task { 2 * 2 }
def p2 = task { 4 * 4 }
def p3 = task { 8 * 8 }
assert [4,16,64] == waitAll(p1, p2, p3)
```

The `waitAll` method waits synchronously, blocking the current thread, for all of the concurrent tasks to complete.

If you prefer not to block the current thread you can use the `onComplete` method:

```
onComplete([p1,p2,p3]) { List results ->
    assert [4,16,64] == results
}
```

The `waitAll` method will throw an exception if an error occurs executing one of the promises. The `onComplete` method, however, will simply not execute the passed closure if an exception occurs. You can also handle exceptions without blocking:

```
onError([p1,p2,p3]) { Throwable t ->
    println "An error occurred ${t.message}"
}
```

If you have just a single long running promise then the `grails.async.Promise` interface provides a `task` method:

```
import static java.util.concurrent.TimeUnit.*
import static grails.async.Promises.*

Promise p = task {
    // Long running task
}
p.onError { Throwable err ->
    println "An error occurred ${err.message}"
}
p.onComplete { result ->
    println "Promise returned $result"
}
// block until result is called
def result = p.get()
// block for the specified time
def result = p.get(1,MINUTES)
```

Promise Chaining

It is possible to chain several promises and wait for the chain to complete using the `then` method:

```
final polish = { ... }
final transform = { ... }
final save = { ... }
final notify = { ... }

Promise promise = task {
    // long running task
}
promise.then polish then transform then save then {
    // notify end result
}
```

If an exception occurs at any point in the chain it will be propagated back to the caller and the next step in the chain will not be executed.

Promise Lists and Maps

Grails' async API also features the concept of a promise lists and maps. These are represented by `grails.async.PromiseMap` classes respectively.

The easiest way to create a promise list or map is via the `tasks` method of the `Promises` class:

```
import static grails.async.Promises.*

def promiseList = tasks([ { 2 * 2 }, { 4 * 4 }, { 8 * 8 } ])
assert [4,16,64] == promiseList.get()
```

The `tasks` method, when passed a list of closures, returns a `PromiseList`. You can also construct a `PromiseList` manually:

```
import grails.async.*

def list = new PromiseList()
list << { 2 * 2 }
list << { 4 * 4 }
list << { 8 * 8 }
list.onComplete { List results ->
    assert [4,16,64] == results
}
```



The `PromiseList` class does not implement the `java.util.List` interface, but instead returns `get()` method

Working with `PromiseMap` instances is largely similar. Again you can either use the `tasks` method:

```
import static grails.async.Promises.*

def promiseList = tasks one:{ 2 * 2 },
                        two:{ 4 * 4 },
                        three:{ 8 * 8 }

assert [one:4,two:16,three:64] == promiseList.get()
```

Or construct a `PromiseMap` manually:

```
import grails.async.*

def map = new PromiseMap()
map['one'] = { 2 * 2 }
map['two'] = { 4 * 4 }
map['three'] = { 8 * 8 }
map.onComplete { Map results ->
    assert [one:4,two:16,three:64] == results
}
```

Promise Factories

The Promises class uses a `grails.async.PromiseFactory` instance to create Promise instances.

The default implementation uses the GParc concurrency library and is called `org.grails.async.factory.DefaultPromiseFactory`, however it is possible to swap implementations by setting the `Promises.promiseFactory` variable.

One common use case for this is unit testing, typically you do not want promises to execute asynchronously. For this purpose Grails ships with a `org.grails.async.factory.SynchronousPromiseFactory` which can be used to create synchronous promises:

```
import org.grails.async.factory.*
import grails.async.*

Promises.promiseFactory = new SynchronousPromiseFactory()
```

Grails also has a `org.grails.async.factory.reactor.ReactorPromiseFactory` which can be used to create reactive promises. To set this as the default, set `Promises.promiseFactory` as given above.

Using the PromiseFactory mechanism it is theoretically possible to plug in other concurrency libraries to override the two interfaces `grails.async.Promise` and `grails.async.PromiseFactory`.

DelegateAsync Transformation

It is quite common to require both synchronous and asynchronous versions of the same API. Developers typically the asynchronous API would simply delegate to the synchronous version.

The DelegateAsync transformation is designed to mitigate this problem by transforming any synchronous method into an asynchronous one.

For example, consider the following service:

```
class BookService {
    List<Book> findBooks(String title) {
        // implementation
    }
}
```

The `findBooks` method executes synchronously in the same thread as the caller. To make an asynchronous class as follows:

```
import grails.async.*

class AsyncBookService {
    @DelegateAsync BookService bookService
}
```

The `DelegateAsync` transformation will automatically add a new method that looks like the following:

```
Promise<List<Book>> findBooks(String title) {
    Promises.task {
        bookService.findBooks(title)
    }
}
```

As you see the transform adds equivalent methods that return a `Promise` and execute asynchronously.

The `AsyncBookService` can then be injected into other controllers and services and used as follows:

```
AsyncBookService asyncBookService
def findBooks(String title) {
    asyncBookService.findBooks(title)
        .onComplete { List results ->
            println "Books = ${results}"
        }
}
```

11.2 Events

Grails 3.0 introduces a new Events API based on [Reactor](#).

All services and controllers in Grails 3.0 implement the [Events](#) trait.

The `Events` trait allows the ability to consume and publish events that are handled by Reactor.

The default Reactor configuration utilises a thread pool backed event bus. You can however configure Rea

```
reactor:
  dispatchers:
    default: myExecutor
  myExecutor:
    type: threadPoolExecutor
    size: 5
    backlog: 2048
```

11.2.1 Consuming Events

There are several ways to consume an event. As mentioned previously services and controllers implement

The `Events` trait provides several methods to register event consumers. For example:

```
on("myEvent") {
  println "Event fired!"
}
```

Note that if you wish a class (other than a controller or service) to be an event consumer you simply have class is registered as a Spring bean.

For example given the following class:

```
import grails.events.*
import javax.annotation.*

class MyClass implements Events {
    @PostConstruct
    void init() {
        on("myEvent") {
            println "Event fired!"
        }
    }
}
```

You can override `doWithSpring` in your `Application` class to register it as a Spring bean (or annota

```
Closure doWithSpring() {
    { ->
        myClass(MyClass)
    }
}
```

11.2.2 Event Notification

The `Events` trait also provides methods for notifying of events. For example:

```
notify "myEvent", "myData"
sendAndReceive "myEvent", "myData", {
    println "Got response!"
}
```

11.2.3 Reactor Spring Annotations

Reactor provides a few useful annotations that can be used for declaratively consuming events in a Grails s

To declare an event consumer use the `Consumer` annotation:

```
import reactor.spring.context.annotation.*

@Consumer
class MyService {

}
```

Then to register to listen for an event use the `Selector` annotation:

```
import reactor.spring.context.annotation.*

@Consumer
class MyService {
    @Selector('my.event')
    void myEventListener(Object data) {
        println "GOT EVENT $data"
    }
}
```

11.2.4 Events from GORM

GORM defines a [number of useful events](#) that you can listen for.

Each event is translated into a key that starts with `gorm:`. For example:

```
import org.grails.datastore.mapping.engine.event.*
...
on("gorm:preInsert") { PreInsertEvent event ->
    println "GOT EVENT $event"
}
```



These events are triggered asynchronously, and so cannot cancel or manipulate the persistence. To do that see the section on [Events & Auto Timestamping](#) in the GORM docs

11.2.5 Events from Spring

Spring also fires a number of useful events. All events in the `org.springframework` package are preferred. For example:

```
import org.springframework.web.context.support.*
import org.springframework.boot.context.event.*
...
on("spring:applicationStarted") { ApplicationStartedEvent event ->
    // fired when the application starts
}
on("spring:servletRequestHandled") { RequestHandledEvent event ->
    // fired each time a request is handled
}
```

11.3 Asynchronous GORM

Since Grails 2.3, GORM features an asynchronous programming model that works across all supported data



Although GORM executes persistence operations asynchronously, these operations still block drivers are not asynchronous. Asynchronous GORM is designed to allow you to isolate these separate thread you can scale and control allowing your controller layer to remain non-blocking

Async Namespace

The Asynchronous GORM API is available on every domain class via the `async` namespace.

For example, the following code listing reads 3 objects from the database asynchronously:

```
import static grails.async.Promises.*

def p1 = Person.async.get(1L)
def p2 = Person.async.get(2L)
def p3 = Person.async.get(3L)
def results = waitAll(p1, p2, p3)
```

Using the `async` namespace, all the regular GORM methods are available (even dynamic finders), but they run in the background and a `Promise` instance is returned.

The following code listing shows a few common examples of GORM queries executed asynchronously:

```
import static grails.async.Promises.*

Person.async.list().onComplete { List results ->
    println "Got people = ${results}"
}
def p = Person.async.getAll(1L, 2L, 3L)
List results = p.get()

def p1 = Person.async.findByFirstName("Homer")
def p2 = Person.async.findByFirstName("Bart")
def p3 = Person.async.findByFirstName("Barney")
results = waitAll(p1, p2, p3)
```

Async and the Session

When using GORM async each promise is executed in a different thread. Since the Hibernate session is n thread.

This is an important consideration when using GORM async (particularly with Hibernate as the p asynchronous queries will be detached entities.

This means you cannot save objects returned from asynchronous queries without first merging them back work:

```
def promise = Person.async.findByFirstName("Homer")
def person = promise.get()
person.firstName = "Bart"
person.save()
```

Instead you need to merge the object with the session bound to the calling thread. The above code needs to

```
def promise = Person.async.findByFirstName("Homer")
def person = promise.get()
person.merge()
person.firstName = "Bart"
```

Note that merge() is called first because it may refresh the object from the cache or database, which we is not recommended to read and write objects in different threads and you should avoid this technique unle

Finally, another issue with detached objects is that association lazy loading **will not** work and you will encounter errors if you do so. If you plan to access the associated objects of those returned from asynchronous calls (the recommended way to avoid N+1 problems).

Multiple Asynchronous GORM calls

As discussed in the previous section you should avoid reading and writing objects in different threads as much as possible. However, if you wish to do more complex GORM work asynchronously then the GORM async namespace makes it possible. For example:

```
def promise = Person.async.task {
  withTransaction {
    def person = findByFirstName("Homer")
    person.firstName = "Bart"
    person.save(flush:true)
  }
}

Person updatedPerson = promise.get()
```

Note that the GORM task method differs from the static `Promises.task` method in that it deals with a thread for you. If you do not use the GORM version and do asynchronous work with GORM then you need to use the static method.

```
import static grails.async.Promises.*

def promise = task {
  Person.withNewSession {
    // your logic here
  }
}
```

Async DetachedCriteria

The `DetachedCriteria` class also supports the async namespace. For example you can do the following:

```
DetachedCriteria query = Person.where {
  lastName == "Simpson"
}

def promise = query.async.list()
```

11.4 Asynchronous Request Handling

If you are deploying to a Servlet 3.0 container such as Tomcat 7 and above then it is possible to deal with r

In general for controller actions that execute quickly there is little benefit in handling requests asynchron actions it is extremely beneficial.

The reason being that with an asynchronous / non-blocking response, the one thread == one request == on can keep a client response open and active, and at the same time return the thread back to the container to c

For example, if you have 70 available container threads and an action takes a minute to complete, if the ac the likelihood of all 70 threads being occupied and the container not being able to respond is quite high processing.

Since Grails 2.3, Grails features a simplified API for creating asynchronous responses built on the Promis

The implementation is based on Servlet 3.0 async. So, to enable the async features you need to set your ser

```
grails:
  servlet:
    version: 3.0
```

Async Models

A typical activity in a Grails controller is to produce a model (a map of key/value pairs) that can be render

If the model takes a while to produce then the server could arrive at a blocking state, impacting s asynchronously by returning a `grails.async.PromiseMap` via the `Promises.tasks` method:

```
import static grails.async.Promises.*
...
def index() {
  tasks books: Book.async.list(),
        totalBooks: Book.async.count(),
        otherValue: {
          // do hard work
        }
}
```

Grails will handle the response asynchronously, waiting for the promises to complete before rendering the above is:

```
def index() {
  def otherValue = ...
  [ books: Book.list() ,
    totalBooks: Book.count(),
    otherValue: otherValue ]
}
```

You can even render different view by passing the PromiseMap to the model attribute of the render r

```
import static grails.async.Promises.*
...
def index() {
  render view:"myView", model: tasks( one:{ 2 * 2 },
                                       two:{ 3 * 3 } )
}
```

Async Response Rendering

You can also write to the response asynchronously using promises in Grails 2.3 and above:

```
import static grails.async.Promises.*
class StockController {
  def stock(String ticker) {
    task {
      ticker = ticker ?: 'GOOG'
      def url = new URL("http://download.finance.yahoo.com/d/quotes.csv?s=${
        Double price = url.text.split(',')[ -1 ] as Double
      render "ticker: $ticker, price: $price"
    }
  }
}
```

The above example using Yahoo Finance to query stock prices, executing asynchronously and only re obtained. This is done by returning a Promise instance from the controller action.

If the Yahoo URL is unresponsive the original request thread will not be blocked and the container will no

11.5 Servlet 3.0 Async

In addition to the higher level async features discussed earlier in the section, you can access the raw application.

Servlet 3.0 Asynchronous Rendering

You can render content (templates, binary data etc.) in an asynchronous manner by calling the `startAsync()` method on the `Servlet 3.0 AsyncContext`. Once you have a reference to the `AsyncContext` you can use Grails' `render()` method to render the content.

```
def index() {
  def ctx = startAsync()
  ctx.start {
    new Book(title:"The Stand").save()
    render template:"books", model:[books:Book.list()]
    ctx.complete()
  }
}
```

Note that you must call the `complete()` method to terminate the connection.

Resuming an Async Request

You resume processing of an async request (for example to delegate to view rendering) by using the `dispatch()` method on the `AsyncContext`.

```
def index() {
  def ctx = startAsync()
  ctx.start {
    // do working
    ...
    // render view
    ctx.dispatch()
  }
}
```

12 Validation

Grails validation capability is built on [Spring's Validator API](#) and data binding capabilities. However Grails also defines validation "constraints" with its constraints mechanism.

Constraints in Grails are a way to declaratively specify validation rules. Most commonly they are applied to [Command Objects](#) also support constraints.

12.1 Declaring Constraints

Within a domain class [constraints](#) are defined with the constraints property that is assigned a code block:

```
class User {
    String login
    String password
    String email
    Integer age

    static constraints = {
        // ...
    }
}
```

You then use method calls that match the property name for which the constraint applies in combination with

```
class User {
    // ...
    static constraints = {
        login size: 5..15, blank: false, unique: true
        password size: 5..15, blank: false
        email email: true, blank: false
        age min: 18
    }
}
```

In this example we've declared that the `login` property must be between 5 and 15 characters long, it can be blank, and it must be unique. We've also applied other constraints to the `password`, `email` and `age` properties.



By default, all domain class properties are not nullable (i.e. they have an implicit nullable constraint).

A complete reference for the available constraints can be found in the Quick Reference section under the Constraints tab. Note that constraints are only evaluated once which may be relevant for a constraint that relies on a value from another constraint.

```
class User {
    ...
    static constraints = {
        // this Date object is created when the constraints are evaluated, not
        // each time an instance of the User class is validated.
        birthDate max: new Date()
    }
}
```

A word of warning - referencing domain class properties from constraints

It's very easy to attempt to reference instance variables from the static constraints block, but this isn't legal. You'll get a `MissingPropertyException` for your trouble. For example, you may try

```
class Response {
    Survey survey
    Answer answer

    static constraints = {
        survey blank: false
        answer blank: false, inList: survey.answers
    }
}
```

See how the `inList` constraint references the instance property `survey`? That won't work. Instead, use a custom validator:

```
class Response {
    ...
    static constraints = {
        survey blank: false
        answer blank: false, validator: { val, obj -> val in obj.survey.answers }
    }
}
```

In this example, the `obj` argument to the custom validator is the domain *instance* that is being validated. The custom validator must return a boolean to indicate whether the new value for the `answer` property, `val`, is valid.

12.2 Validating Constraints

Validation Basics

Call the [validate](#) method to validate a domain class instance:

```
def user = new User(params)

if (user.validate()) {
    // do something with user
}
else {
    user.errors.allErrors.each {
        println it
    }
}
```

The errors property on domain classes is an instance of the Spring [Errors](#) interface. The Errors interface provides methods to add errors and also retrieve the original values.

Validation Phases

Within Grails there are two phases of validation, the first one being [data binding](#) which occurs when you bind

```
def user = new User(params)
```

At this point you may already have errors in the errors property due to type conversion (such as converting a string to an integer). You can obtain the original input value using the Errors API:

```
if (user.hasErrors()) {
    if (user.errors.hasFieldErrors("login")) {
        println user.errors.getFieldError("login").rejectedValue
    }
}
```

The second phase of validation happens when you call [validate](#) or [save](#). This is when Grails will validate the domain class against the constraints defined. For example, by default the [save](#) method calls validate before executing, allowing you to write

```

if (user.save()) {
    return user
}
else {
    user.errors.allErrors.each {
        println it
    }
}

```

12.3 Sharing Constraints Between Classes

A common pattern in Grails is to use [command objects](#) for validating user-submitted data and then copy relevant domain classes. This often means that your command objects and domain classes share properties and paste the constraints between the two, but that's a very error-prone approach. Instead, make use of Grails' [Global Constraints](#).

Global Constraints

In addition to defining constraints in domain classes, command objects and [other validateable classes](#), you can define global constraints in `grails-app/conf/application.groovy`:

```

grails.gorm.default.constraints = {
    '*'(nullable: true, size: 1..20)
    myShared(nullable: false, blank: false)
}

```

These constraints are not attached to any particular classes, but they can be easily referenced from any validateable class:

```

class User {
    ...

    static constraints = {
        login shared: "myShared"
    }
}

```

Note the use of the `shared` argument, whose value is the name of one of the constraints defined in `grails.gorm.default.constraints`. Despite the name of the configuration setting, you can reference these shared constraints from any validateable class.

The `'*'` constraint is a special case: it means that the associated constraints ('nullable' and 'size' in the above example) are applied to all validateable classes. These defaults can be overridden by the constraints declared in a validateable class.

Importing Constraints

Grails 2 introduced an alternative approach to sharing constraints that allows you to import a set of constraints.

Let's say you have a domain class like so:

```
class User {
    String firstName
    String lastName
    String passwordHash

    static constraints = {
        firstName blank: false, nullable: false
        lastName blank: false, nullable: false
        passwordHash blank: false, nullable: false
    }
}
```

You then want to create a command object, `UserCommand`, that shares some of the properties of the `User` class. You do this with the `importFrom()` method:

```
class UserCommand {
    String firstName
    String lastName
    String password
    String confirmPassword

    static constraints = {
        importFrom User
        password blank: false, nullable: false
        confirmPassword blank: false, nullable: false
    }
}
```

This will import all the constraints from the `User` domain class and apply them to `UserCommand`. The class (`User`) that don't have corresponding properties in the importing class (`UserCommand`). In 'lastName' constraints will be imported into `UserCommand` because those are the only properties shared between the two classes.

If you want more control over which constraints are imported, use the `include` and `exclude` argument with regular expression strings that are matched against the property names in the source constraints. So for example, to import only constraints for properties starting with 'password' you would use:

```
...
static constraints = {
    importFrom User, include: ["lastName"]
    ...
}
```

or if you wanted all constraints that ended with 'Name':

```
...
static constraints = {
    importFrom User, include: [/.*Name/]
    ...
}
```

Of course, `exclude` does the reverse, specifying which constraints should *not* be imported.

12.4 Validation on the Client

Displaying Errors

Typically if you get a validation error you redirect back to the view for rendering. Once there you need a rich set of tags for dealing with errors. To render the errors as a list you can use [renderErrors](#):

```
<g:renderErrors bean="${user}" />
```

If you need more control you can use [hasErrors](#) and [eachError](#):

```
<g:hasErrors bean="${user}">
    <ul>
        <g:eachError var="err" bean="${user}">
            <li>${err}</li>
        </g:eachError>
    </ul>
</g:hasErrors>
```

Highlighting Errors

It is often useful to highlight using a red box or some indicator when a field has been incorrectly input invoking it as a method. For example:

```
<div class='value ${hasErrors(bean:user,field:'login','errors')}'>
  <input type="text" name="login" value="${fieldValue(bean:user,field:'login')}"
</div>
```

This code checks if the login field of the user bean has any errors and if so it adds an errors CSS class to highlight the div.

Retrieving Input Values

Each error is actually an instance of the [FieldError](#) class in Spring, which retains the original input value object to restore the value input by the user using the [fieldValue](#) tag:

```
<input type="text" name="login" value="${fieldValue(bean:user,field:'login')}" />
```

This code will check for an existing `FieldError` in the `User` bean and if there is obtain the originally input value.

12.5 Validation and Internationalization

Another important thing to note about errors in Grails is that error messages are not hard coded anywhere but are retrieved from message bundles using Grails' [i18n](#) support.

Constraints and Message Codes

The codes themselves are dictated by a convention. For example consider the constraints we looked at earlier.

```
package com.mycompany.myapp

class User {
    ...
    static constraints = {
        login size: 5..15, blank: false, unique: true
        password size: 5..15, blank: false
        email email: true, blank: false
        age min: 18
    }
}
```

If a constraint is violated Grails will by convention look for a message code of the form:

```
[Class Name].[Property Name].[Constraint Code]
```

In the case of the blank constraint this would be `user.login.blank` so you would need `grails-app/i18n/messages.properties` file:

```
user.login.blank=Your login name must be specified!
```

The class name is looked for both with and without a package, with the packaged version `com.mycompany.myapp.User.login.blank` will be used before `user.login.blank`. This allows for cases where plugin's.

For a reference on what codes are for which constraints refer to the reference guide for each constraint.

Displaying Messages

The [renderErrors](#) tag will automatically look up messages for you using the [message](#) tag. If you need yourself:

```

<g:hasErrors bean="${user}">
  <ul>
    <g:eachError var="err" bean="${user}">
      <li><g:message error="${err}" /></li>
    </g:eachError>
  </ul>
</g:hasErrors>

```

In this example within the body of the [eachError](#) tag we use the [message](#) tag in combination with its `err` error.

12.6 Applying Validation to Other Classes

[Domain classes](#) and [command objects](#) support validation by default. Other classes may be made valid property in the class (as described above) and then telling the framework about them. It is important that with the framework. Simply defining the `constraints` property is not sufficient.

The Validateable Trait

Classes which define the static `constraints` property and implement the [Validateable](#) trait will be valid

```

// src/groovy/com/mycompany/myapp/User.groovy
package com.mycompany.myapp

import grails.validation.Validateable

class User implements Validateable {
  ...

  static constraints = {
    login size: 5..15, blank: false, unique: true
    password size: 5..15, blank: false
    email email: true, blank: false
    age min: 18
  }
}

```

13 The Service Layer

Grails defines the notion of a service layer. The Grails team discourages the embedding of core application logic in controllers, views, and so on, and a clean separation of concerns.

Services in Grails are the place to put the majority of the logic in your application, leaving controllers responsible for handling requests and so on.

Creating a Service

You can create a Grails service by running the [create-service](#) command from the root of your project in a terminal:

```
grails create-service helloworld.simple
```



If no package is specified with the create-service script, Grails automatically uses the application package name.

The above example will create a service at the location `grails-app/services/helloworld/SimpleService`, other than that a service is a plain Groovy class:

```
package helloworld

class SimpleService {
}
```

13.1 Declarative Transactions

Declarative Transactions

Services are typically involved with coordinating logic between [domain classes](#), and hence often involve transactional behaviour. Given the nature of services, they frequently require transactional behaviour. You can use programmatic transactions, however this is repetitive and doesn't fully leverage the power of Spring's underlying transaction abstraction.

Services enable transaction demarcation, which is a declarative way of defining which methods are to be transactional. Service methods use the `Transactional` transform:

```
import grails.transaction.*

@Transactional
class CountryService {

}
```

The result is that all methods are wrapped in a transaction and automatic rollback occurs if a method throws a `RuntimeException` or an `Error`. The propagation level of the transaction is by default set to [PROPAGATION_REQUIRED](#).



Checked exceptions do **not** roll back transactions. Even though Groovy blurs the distinction between checked and unchecked exceptions, Spring isn't aware of this and its default behaviour is used, so it's the distinction between checked and unchecked exceptions.



Warning: [dependency injection](#) is the **only** way that declarative transactions work. You will not be able to use the `new` operator such as `new BookService()` if you use the new operator.

The Transactional annotation vs the transactional property

In previous versions of Grails prior to Grails 3.1, Grails created Spring proxies and used the transactional property. These proxies are disabled by default in Grails 3.1 and above in favour of the `@Transactional` annotation.

If you wish to reenable this feature (not recommended) then you must set `grails.spring.transaction.proxy.enabled=true` in `grails-app/conf/application.yml` or `grails-app/conf/application.groovy`.



In addition, prior to Grails 3.1 services were transactional by default, as of Grails 3.1 they are not. The `@Transactional` annotation is applied.

Custom Transaction Configuration

Grails also provides `@Transactional` and `@NotTransactional` annotations for cases where you need to specify an alternative propagation level. For example, the `@NotTransactional` annotation can be used to skip a particular method to be skipped when a class is annotated with `@Transactional`.



The `grails.transaction.Transactional` annotation was first introduced in Grails 3.1. The `@Transactional` annotation was used.



Annotating a service method with `Transactional` disables the default Grails transactional behavior (the same way that adding `transactional=false` does) so if you use any annotations that require transactions.

In this example `listBooks` uses a read-only transaction, `updateBook` uses a default read-write transaction (probably not a good idea given its name).

```
import grails.transaction.Transactional

class BookService {
    @Transactional(readOnly = true)
    def listBooks() {
        Book.list()
    }

    @Transactional
    def updateBook() {
        // ...
    }

    def deleteBook() {
        // ...
    }
}
```

You can also annotate the class to define the default transaction behavior for the whole service, and then this service is equivalent to one that has no annotations (since the default is implicitly `transactional=true`).

```
import grails.transaction.Transactional

@Transactional
class BookService {
    def listBooks() {
        Book.list()
    }

    def updateBook() {
        // ...
    }

    def deleteBook() {
        // ...
    }
}
```

This version defaults to all methods being read-write transactional (due to the class-level annotation), but `listBooks` is a read-only transaction:


```

import grails.transaction.Transactional

@Transactional
class BookService {

    @Transactional(readOnly = true)
    def listBooks() {
        Book.list()
    }

    def updateBook() {
        // ...
    }

    def deleteBook() {
        // ...
    }
}

```

Although `updateBook` and `deleteBook` aren't annotated in this example, they inherit the configuration.

For more information refer to the section of the Spring user guide on [Using @Transactional](#).

Unlike Spring you do not need any prior configuration to use `Transactional`; just specify the annotation automatically.

13.1.1 Transactions Rollback and the Session

Understanding Transactions and the Hibernate Session

When using transactions there are important considerations you must take into account with regards to how by Hibernate. When a transaction is rolled back the Hibernate session used by GORM is cleared. This detached and accessing uninitialized lazy-loaded collections will lead to `LazyInitializationException`.

To understand why it is important that the Hibernate session is cleared. Consider the following example:

```

class Author {
    String name
    Integer age

    static hasMany = [books: Book]
}

```

If you were to save two authors using consecutive transactions as follows:

```

Author.withTransaction { status ->
    new Author(name: "Stephen King", age: 40).save()
    status.setRollbackOnly()
}

Author.withTransaction { status ->
    new Author(name: "Stephen King", age: 40).save()
}

```

Only the second author would be saved since the first transaction rolls back the author `save()` by clearing the session. If the session were not cleared then both author instances would be persisted and it would lead to very unexpected results.

It can, however, be frustrating to get `LazyInitializationExceptions` due to the session being cleared.

For example, consider the following example:

```

class AuthorService {
void updateAge(id, int age) {
    def author = Author.get(id)
    author.age = age
    if (author.isTooOld()) {
        throw new AuthorException("too old", author)
    }
}
}

```

```

class AuthorController {
def authorService
def updateAge() {
    try {
        authorService.updateAge(params.id, params.int("age"))
    }
    catch(e) {
        render "Author books ${e.author.books}"
    }
}
}


```

In the above example the transaction will be rolled back if the Author's age exceeds the maximum, throwing an `AuthorException`. The `AuthorException` references the author but when the session is cleared, a `LazyInitializationException` will be thrown because the underlying Hibernate session has been closed.

To solve this problem you have a number of options. One is to ensure you query eagerly to get the data you

```
class AuthorService {  
  ...  
  void updateAge(id, int age) {  
    def author = Author.findById(id, [fetch:[books:"eager"]])  
    ...  
  }  
}
```

In this example the books association will be queried when retrieving the Author.

 This is the optimal solution as it requires fewer queries than the following suggested solutions

Another solution is to redirect the request after a transaction rollback:

```
class AuthorController {  
  AuthorService authorService  
  def updateAge() {  
    try {  
      authorService.updateAge(params.id, params.int("age"))  
    }  
    catch(e) {  
      flash.message = "Can't update age"  
      redirect action:"show", id:params.id  
    }  
  }  
}
```

In this case a new request will deal with retrieving the Author again. And, finally a third solution is to ensure the session remains in the correct state:

```

class AuthorController {
  def authorService
  def updateAge() {
    try {
      authorService.updateAge(params.id, params.int("age"))
    }
    catch(e) {
      def author = Author.read(params.id)
      render "Author books ${author.books}"
    }
  }
}

```

Validation Errors and Rollback

A common use case is to rollback a transaction if there are validation errors. For example consider this ser

```

import grails.validation.ValidationException

class AuthorService {
  void updateAge(id, int age) {
    def author = Author.get(id)
    author.age = age
    if (!author.validate()) {
      throw new ValidationException("Author is not valid", author.errors)
    }
  }
}

```

To re-render the same view that a transaction was rolled back in you can re-associate the errors with a refr

```

import grails.validation.ValidationException

class AuthorController {
    def authorService
    def updateAge() {
        try {
            authorService.updateAge(params.id, params.int("age"))
        }
        catch (ValidationException e) {
            def author = Author.read(params.id)
            author.errors = e.errors
            render view: "edit", model: [author:author]
        }
    }
}

```

13.2 Scoped Services

By default, access to service methods is not synchronised, so nothing prevents concurrent execution of a singleton and may be used concurrently, you should be very careful about storing state in a service. Or take care of synchronisation in a service.

You can change this behaviour by placing a service in a particular scope. The supported scopes are:

- **prototype** - A new service is created every time it is injected into another class
- **request** - A new service will be created per request
- **flash** - A new service will be created for the current and next request only
- **flow** - In web flows the service will exist for the scope of the flow
- **conversation** - In web flows the service will exist for the scope of the conversation. ie a root flow
- **session** - A service is created for the scope of a user session
- **singleton** (default) - Only one instance of the service ever exists



If your service is **flash**, **flow** or **conversation** scoped it must implement `java.io.Serializable` and only be used in the context of a Web Flow.

To enable one of the scopes, add a static scope property to your class whose value is one of the above, for example:

```

static scope = "flow"

```



Upgrade note: Starting with Grails 2.3, new applications are generated with configuration controllers to singleton. If singleton controllers interact with prototype scoped services, they will behave as per-controller singletons. If non-singleton services are required, controller scope should be used. See [Controllers and Scopes](#) in the user guide for more information.

13.3 Dependency Injection and Services

Dependency Injection Basics

A key aspect of Grails services is the ability to use [Spring Framework](#)'s dependency injection feature, called "constructor injection by property name convention". In other words, you can use the property name representation of the class name of a service to inject dependencies from other services, libraries, and so on.

As an example, given a service called `BookService`, if you define a property called `bookService` in

```
class BookController {
    def bookService
    ...
}
```

In this case, the Spring container will automatically inject an instance of that service based on its configuration name. You can also specify the type as follows:

```
class AuthorService {
    BookService bookService
}
```



NOTE: Normally the property name is generated by lower casing the first letter of the type. For example, the `BookService` class would map to a property named `bookService`.

To be consistent with standard JavaBean conventions, if the first 2 letters of the class name are the same as the class name. For example, the property name of the `JDBCHelperService` is `jDBCHelperService`, not `jdbCHelperService` or `jdbchelperService`.

See section 8.8 of the JavaBean specification for more information on de-capitalization rules.



Only the top level object is subjected to injection as traversing all nested objects to perform injection is a performance issue.

Dependency Injection and Services

You can inject services in other services with the same technique. If you had an `AuthService` that n `AuthService` as follows would allow that:

```
class AuthService {  
    def bookService  
}
```

Dependency Injection and Domain Classes / Tag Libraries

You can even inject services into domain classes and tag libraries, which can aid in the development of rich

```
class Book {  
    ...  
    def bookService  
    def buyBook() {  
        bookService.buyBook(this)  
    }  
}
```

Service Bean Names

The default bean name which is associated with a service can be problematic if there are multiple ser packages. For example consider the situation where an application defines a service class named `com.demo.reporting.ReportService` and uses a plugin named `ReportingUtilities` and that plugin provides a service class named `com.reporting.ReportService`. The default bean name for each of those would be `reportingService` so they would conflict with each other. To avoid this, the application can prefix the bean name for services provided by plugins by prefixing the bean name with the plugin name. In the scenario above, the bean would be an instance of the `com.demo.reporting.ReportService` class defined by the `ReportingUtilities` plugin. For all service beans provided by plugins, if there are no other beans of the same type in the application or other plugins in the application then a bean alias will be created which does not include the prefix. For example, if the `ReportingUtilities` plugin provides an `AuthService` and there is no other `AuthService` in the application then there will be a bean named `reportingUtilitiesAuthService` and there will be a bean alias defined in the context named `AuthService` that refers to the same bean.

14 Static Type Checking And Compilation

Groovy is a dynamic language and by default Groovy uses a dynamic dispatch mechanism to carry out its dispatch mechanism provides a lot of flexibility and power to the language. For example, it is possible to dynamically replace existing methods at runtime. Features like these are important. However, there are times when you may want to disable this dynamic dispatch in favor of a more static dispatch to do that. The way to tell the Groovy compiler that a particular class should be compiled statically is the [groovy.transform.CompileStatic](#) annotation as shown below.

```
import groovy.transform.CompileStatic

@CompileStatic
class MyClass {

    // this class will be statically compiled...
}
```

See [these notes on Groovy static compilation](#) for more details on how `CompileStatic` works and why it is useful.

One limitation of using `CompileStatic` is that when you use it you give up access to the power of dynamic dispatch. For example, in Grails you would not be able to invoke a GORM dynamic finder from a class that is marked `CompileStatic` because it doesn't exist at compile time. It may be that you want the compilation benefits without giving up access to dynamic dispatch for Grails specific things. [grails.compiler.GrailsCompileStatic](#) comes in. `GrailsCompileStatic` behaves just like `CompileStatic` but allows access to those specific features to be accessed dynamically.

14.1 The GrailsCompileStatic Annotation

GrailsCompileStatic

The `GrailsCompileStatic` annotation may be applied to a class or methods within a class.


```

import grails.compiler.GrailsCompileStatic

@GrailsCompileStatic
class SomeClass {

    // all of the code in this class will be statically compiled

    def methodOne() {
        // ...
    }

    def methodTwo() {
        // ...
    }

    def methodThree() {
        // ...
    }
}

```

```

import grails.compiler.GrailsCompileStatic

class SomeClass {

    // methodOne and methodThree will be statically compiled
    // methodTwo will be dynamically compiled

    @GrailsCompileStatic
    def methodOne() {
        // ...
    }

    def methodTwo() {
        // ...
    }

    @GrailsCompileStatic
    def methodThree() {
        // ...
    }
}

```

It is possible to mark a class with `GrailsCompileStatic` and exclude specific methods by marking specifying that the type checking should be skipped for that particular method as shown below.

```

import grails.compiler.GrailsCompileStatic
import groovy.transform.TypeCheckingMode

@GrailsCompileStatic
class SomeClass {

    // methodOne and methodThree will be statically compiled
    // methodTwo will be dynamically compiled

    def methodOne() {
        // ...
    }

    @GrailsCompileStatic(TypeCheckingMode.SKIP)
    def methodTwo() {
        // ...
    }

    def methodThree() {
        // ...
    }
}

```

Code that is marked with `GrailsCompileStatic` will all be statically compiled except for Grails DSL code in configuration blocks like constraints and mapping closures in domain classes.

Care must be taken when deciding to statically compile code. There are benefits associated with static compilation but you are giving up the power and flexibility of dynamic dispatch. For example if code is statically compiled you are giving up the power and flexibility of dynamic dispatch. For example if code is statically compiled you are giving up the power and flexibility of dynamic dispatch. For example if code is statically compiled you are giving up the power and flexibility of dynamic dispatch.

14.2 The `GrailsTypeChecked` Annotation

`GrailsTypeChecked`

The [grails.compiler.GrailsTypeChecked](#) annotation works a lot like the `GrailsCompileStatic` annotation, not static compilation. This affords compile time feedback for expressions which cannot be statically compiled, leaving dynamic dispatch in place for the class.

```
import grails.compiler.GrailsTypeChecked

@GrailsTypeChecked
class SomeClass {

    // all of the code in this class will be statically type
    // checked and will be dynamically dispatched at runtime

    def methodOne() {
        // ...
    }

    def methodTwo() {
        // ...
    }

    def methodThree() {
        // ...
    }
}
```

15 Testing

Automated testing is a key part of Grails. Hence, Grails provides many ways to making testing easier from tests. This section details the different capabilities that Grails offers for testing.



Grails 1.3.x and below used the `grails.test.GrailsUnitTestCase` class hierarchy. Grails 2.0.x and above deprecates these test harnesses in favour of mixins that can be applied to tests (JUnit 3, JUnit 4, Spock etc.) without subclassing.

The first thing to be aware of is that all of the `create-*` and `generate-*` commands create unit tests. For example if you run the [create-controller](#) command as follows:

```
grails create-controller com.acme.app.simple
```

Grails will create a controller at `grails-app/controllers/com/acme/app/SimpleController` and a unit test at `test/unit/com/acme/app/SimpleControllerTests.groovy`. What Grails won't do however is left up to you.



The default class name suffix is `Tests` but as of Grails 1.2.2, the suffix of `Test` is also supported.

Running Tests

Tests are run with the [test-app](#) command:

```
grails test-app
```

The command will produce output such as:

```
-----  
Running Unit Tests...  
Running test FooTests...FAILURE  
Unit Tests Completed in 464ms ...  
-----  
  
Tests failed: 0 errors, 1 failures
```

whilst showing the reason for each test failure.



You can force a clean before running tests by passing `-clean` to the `test-app` command.

Grails writes both plain text and HTML test reports to the `target/test-reports` directory, along with `test-reports` which are generally the best ones to look at.

Using Grails' [interactive mode](#) confers some distinct advantages when executing tests. First, the tests will only run on subsequent runs. Second, a shortcut is available to open the HTML reports in your browser:

```
open test-report
```

You can also run your unit tests from within most IDEs.

Targeting Tests

You can selectively target the test(s) to be run in different ways. To run all tests for a controller named `SimpleController`:

```
grails test-app SimpleController
```

This will run any tests for the class named `SimpleController`. Wildcards can be used...

```
grails test-app *Controller
```

This will test all classes ending in `Controller`. Package names can optionally be specified...

```
grails test-app some.org.*Controller
```

or to run all tests in a package...

```
grails test-app some.org.*
```

or to run all tests in a package including subpackages...

```
grails test-app some.org.**.*
```

You can also target particular test methods...

```
grails test-app SimpleController.testLogin
```

This will run the `testLogin` test in the `SimpleController` tests. You can specify as many patterns i

```
grails test-app some.org.* SimpleController.testLogin BookController
```



In Grails 2.x, adding `-rerun` as an argument would only run those tests which failed in the first run. This argument is no longer supported.

Debugging

In order to debug your tests via a remote debugger, you can add `--debug-jvm` after `grails` in any con

```
grails --debug-jvm test-app
```

This will open the default Java remote debugging port, 5005, for you to attach a remote debugger from you



This differs from Grails 2.3 and previous, where the `grails-debug` command existed.

Targeting Test Phases

In addition to targeting certain tests, you can also target test *phases*. By default Grails has two testing phases



Grails 2.x uses `phase:type` syntax. In Grails 3.0 it was removed, because it made no sense

To execute `unit` tests you can run:

```
grails test-app -unit
```

To run integration tests you would run...

```
grails test-app -integration
```

Targeting Tests When Using Phases

Test and phase targeting can be applied at the same time:

```
grails test-app some.org.**.* -unit
```

This would run all tests in the `unit` phase that are in the package `some.org` or a subpackage.

15.1 Unit Testing

Unit testing are tests at the "unit" level. In other words you are testing individual methods or blocks infrastructure. Unit tests are typically run without the presence of physical resources that involve I/O such ensure they run as quick as possible since quick feedback is important.

The Test Mixins

Since Grails 2.0, a collection of unit testing mixins is provided by Grails that lets you enhance the behavior following sections cover the usage of these mixins.



The previous JUnit 3-style `GrailsUnitTestCase` class hierarchy is still present in Grails but is now deprecated. The previous documentation on the subject can be found in the [Grails 1.3.x](#) documentation.

You won't normally have to import any of the testing classes because Grails does that for you. But if you need to, here they all are:

- `grails.test.mixin.TestFor`
- `grails.test.mixin.Mock`
- `grails.test.mixin.TestMixin`
- `grails.test.mixin.support.GrailsUnitTestMixin`
- `grails.test.mixin.domain.DomainClassUnitTestMixin`
- `grails.test.mixin.services.ServiceUnitTestMixin`
- `grails.test.mixin.web.ControllerUnitTestMixin`
- `grails.test.mixin.web.FiltersUnitTestMixin`
- `grails.test.mixin.web.GroovyPageUnitTestMixin`
- `grails.test.mixin.web.UrlMappingsUnitTestMixin`
- `grails.test.mixin.hibernate.HibernateTestMixin`

Note that you're only ever likely to use the first two explicitly. The rest are there for reference.

Test Mixin Basics

Most testing can be achieved via the `TestFor` annotation in combination with the `Mock` annotation for controller and associated domains you would define the following:


```
@TestFor(BookController)
@Mock([Book, Author, BookService])
```

The `TestFor` annotation defines the class under test and will automatically create a field for the type of controller. A "controller" field will be present, however if `TestFor` was defined for a service a "service" field would be present.

The `Mock` annotation creates mock version of any collaborators. There is an in-memory implementation with the GORM API.

doWithSpring and doWithConfig callback methods, FreshRuntime annotation

The `doWithSpring` callback method can be used to add beans with the BeanBuilder DSL. There is the `doWithConfig` callback method to set the `grailsApplication.config` values before the `grailsApplication` instance of the test runtime gets initialized.

```
import grails.test.mixin.support.GrailsUnitTestMixin
import org.junit.ClassRule
import org.junit.rules.TestRule

import spock.lang.Ignore;
import spock.lang.IgnoreRest
import spock.lang.Shared;
import spock.lang.Specification

@TestMixin(GrailsUnitTestMixin)
class StaticCallbacksSpec extends Specification {
    static doWithSpring = {
        myService(MyService)
    }

    static doWithConfig(c) {
        c.myConfigValue = 'Hello'
    }

    def "grailsApplication is not null"() {
        expect:
        grailsApplication != null
    }

    def "doWithSpring callback is executed"() {
        expect:
        grailsApplication.mainContext.getBean('myService') != null
    }

    def "doWithConfig callback is executed"(){
        expect:
        config.myConfigValue == 'Hello'
    }
}
```

You can also use these callbacks without "static" together with the [grails.test.runtime.FreshRuntime](#) annotation. The `grailsApplication` context and `grailsApplication` instance is initialized for each test method call.

```

import grails.test.mixin.support.GrailsUnitTestMixin
import grails.test.runtime.FreshRuntime;

import org.junit.ClassRule
import org.junit.rules.TestRule

import spock.lang.Ignore;
import spock.lang.IgnoreRest
import spock.lang.Shared;
import spock.lang.Specification

@FreshRuntime
@TestMixin(GrailsUnitTestMixin)
class TestInstanceCallbacksSpec extends Specification {
    def doWithSpring = {
        myService(MyService)
    }

    def doWithConfig(c) {
        c.myConfigValue = 'Hello'
    }

    def "grailsApplication is not null"() {
        expect:
        grailsApplication != null
    }

    def "doWithSpring callback is executed"() {
        expect:
        grailsApplication.mainContext.getBean('myService') != null
    }

    def "doWithConfig callback is executed"(){
        expect:
        config.myConfigValue == 'Hello'
    }
}

```

You can use [org.grails.spring.beans.factory.InstanceFactoryBean](#) together with do mock beans in tests.

```

import grails.test.mixin.support.GrailsUnitTestMixin
import grails.test.runtime.FreshRuntime

import org.grails.spring.beans.factory.InstanceFactoryBean
import org.junit.ClassRule

import spock.lang.Shared
import spock.lang.Specification

@FreshRuntime
@TestMixin(GrailsUnitTestMixin)
class MockedBeanSpec extends Specification {
    def myService=Mock(MyService)

    def doWithSpring = {
        myService(InstanceFactoryBean, myService, MyService)
    }

    def "doWithSpring callback is executed"() {
        when:
        def myServiceBean=grailsApplication.mainContext.getBean('myService')
        myServiceBean.prova()
        then:
        1 * myService.prova() >> { true }
    }
}

```

The DirtiesRuntime annotation

Test methods may be marked with the [grails.test.runtime.DirtiesRuntime](#) annotation to indicate that the runtime state might be problematic for other tests and as such the runtime should be refreshed after this test method.

```

import grails.test.mixin.TestFor
import spock.lang.Specification
import grails.test.runtime.DirtiesRuntime

@TestFor(PersonController)
class PersonControllerSpec extends Specification {

    @DirtiesRuntime
    void "a test method which modifies the runtime"() {
        when:
        Person.metaClass.someMethod = { ... }
        // ...

    then:
        // ...
    }

    void "a test method which should not be affected by the previous test method"() {
        // ...
    }
}

```

Sharing test runtime grailsApplication instance and beans for several test classes

It's possible to share a single grailsApplication instance and beans for several test classes. This feature is implemented by the `SharedRuntimeConfigurer` annotation. This annotation takes an optional class parameter implements [SharedRuntimeConfigurer](#) interface. The implementation class will share the same runtime during a single test run. The annotation can also implement [TestEventInterceptor](#). In this case the instance of the class will be created at runtime.

Loading application beans in unit tests

Adding static `loadExternalBeans = true` field definition to a unit test class makes the Grails application load `grails-app/conf/spring/resources.groovy` and `grails-app/conf/spring/resources.groovy`.

```
import spock.lang.Issue
import spock.lang.Specification
import grails.test.mixin.support.GrailsUnitTestMixin

@TestMixin(GrailsUnitTestMixin)
class LoadExternalBeansSpec extends Specification {
    static loadExternalBeans = true

    void "should load external beans"() {
        expect:
        applicationContext.getBean('simpleBean') == 'Hello world!'
    }
}
```

15.1.1 Unit Testing Controllers

The Basics

You use the `grails.test.mixin.TestFor` annotation to unit test controllers. Using `grails.test.mixin.web.ControllerUnitTestMixin` and its associated API. For example:

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void "test something"() {
    }
}
```

Adding the `TestFor` annotation to a controller causes a new controller field to be automatically created.



The TestFor annotation will also automatically annotate any public methods starting with "test". If any of your test method don't start with "test" just add this manually

To test the simplest "Hello World"-style example you can do the following:

```
// Test class
class SimpleController {
    def hello() {
        render "hello"
    }
}
```

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void "test hello"() {
        when:
            controller.hello()

        then:
            response.text == 'hello'
    }
}
```

The response object is an instance of GrailsMockHttpServletResponse (org.codehaus.groovy.grails.plugins.testing) which extends Spring's MockHttpServletResponse. It has many useful methods for inspecting the state of the response.

For example to test a redirect you can use the redirectedUrl property:

```
class SimpleController {
    def index() {
        redirect action: 'hello'
    }
    ...
}
```

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test index'() {
    when:
        controller.index()

    then:
        response.redirectedUrl == '/simple/hello'
}
}

```

Many actions make use of the parameter data associated with the request. For example, the 'sort', 'max', 'offset' parameters. Providing these in the test is as simple as adding appropriate values to a special params variable:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(PersonController)
class PersonControllerSpec extends Specification {

void 'test list'() {
    when:
        params.sort = 'name'
        params.max = 20
        params.offset = 0
        controller.list()

    then:
        // ...
}
}

```

You can even control what type of request the controller action sees by setting the method property of the request:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(PersonController)
class PersonControllerSpec extends Specification {

    void 'test save'() {
        when:
            request.method = 'POST'
            controller.save()

        then:
            // ...
    }
}

```

This is particularly important if your actions do different things depending on the type of the request. Final

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(PersonController)
class PersonControllerSpec extends Specification {

    void 'test list'() {
        when:
            request.method = 'POST'
            request.makeAjaxRequest()
            controller.getPage()

        then:
            // ...
    }
}

```

You only need to do this though if the code under test uses the xhr property on the request.

Testing View Rendering

To test view rendering you can inspect the state of the controller's `modelAndView` (org.springframework.web.servlet.ModelAndView) or you can use the `view` and `model` p

```
class SimpleController {
    def home() {
        render view: "homePage", model: [title: "Hello World"]
    }
    ...
}
```

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test home'() {
        when:
            controller.home()

        then:
            view == '/simple/homePage'
            model.title == 'Hello World'
    }
}
```

Note that the view string is the absolute view path, so it starts with a '/' and will include path elements controller.

Testing Template Rendering

Unlike view rendering, template rendering will actually attempt to write the template directly to the response, hence it requires a different approach to testing.

Consider the following controller action:

```
class SimpleController {
    def display() {
        render template: "snippet"
    }
}
```

In this example the controller will look for a template in `grails-app/views/simple/_snippet.g`


```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test display'() {
        when:
            controller.display()

        then:
            response.text == 'contents of the template'
    }
}

```

However, you may not want to render the real template, but just test that it was rendered. In this case you can

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test display with mock template'() {
        when:
            views['/_simple/_snippet.gsp'] = 'mock template contents'
            controller.display()

        then:
            response.text == 'mock template contents'
    }
}

```

Testing Actions Which Return A Map

When a controller action returns a `java.util.Map` that Map may be inspected directly to assert that it contains

```

class SimpleController {
    def showBookDetails() {
        [title: 'The Nature Of Necessity', author: 'Alvin Plantinga']
    }
}

```

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test show book details'() {
    when:
        def model = controller.showBookDetails()

    then:
        model.author == 'Alvin Plantinga'
    }
}

```

Testing XML and JSON Responses

XML and JSON response are also written directly to the response. Grails' mocking capabilities provide response. For example consider the following action:

```

def renderXml() {
    render(contentType: "text/xml") {
        book(title: "Great")
    }
}

```

This can be tested using the `xml` property of the response:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test render xml'() {
    when:
        controller.renderXml()

    then:
        response.text == "<book title='Great' />"
        response.xml.@title.text() == 'Great'
    }
}

```

The `xml` property is a parsed result from Groovy's [XmlSlurper](#) class which is very convenient for parsing

Testing JSON responses is pretty similar, instead you use the `json` property:

```
// controller action
def renderJson() {
    render(contentType:"application/json") {
        book = "Great"
    }
}
```

```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test render json'() {
        when:
            controller.renderJson()

        then:
            response.text == '{"book":"Great"}'
            response.json.book == 'Great'
    }
}
```

The `json` property is an instance of `org.codehaus.groovy.grails.web.json.JSONElement` parsing JSON responses.

Testing XML and JSON Requests

Grails provides various convenient ways to automatically parse incoming XML and JSON packets. For example, for XML requests using Grails' data binding:

```
def consumeBook(Book b) {
    render "The title is ${b.title}."
}
```

To test this Grails provides an easy way to specify an XML or JSON packet via the `xml` or `json` property by specifying a String containing the XML:

```

import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(SimpleController)
@Mock([Book])
class SimpleControllerSpec extends Specification {
    void 'test consume book xml'() {
        when:
            request.xml = '<book><title>Wool</title></book>'
            controller.consumeBook()

        then:
            response.text == 'The title is Wool.'
    }
}

```

Or alternatively a domain instance can be specified and it will be auto-converted into the appropriate XML

```

import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(SimpleController)
@Mock([Book])
class SimpleControllerSpec extends Specification {

    void 'test consume book xml'() {
        when:
            request.xml = new Book(title: 'Shift')
            controller.consumeBook()

        then:
            response.text == 'The title is Shift.'
    }
}

```

The same can be done for JSON requests:

```

import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(SimpleController)
@Mock([Book])
class SimpleControllerSpec extends Specification {

void 'test consume book json'() {
    when:
        request.json = new Book(title: 'Shift')
        controller.consumeBook()

    then:
        response.text == 'The title is Shift.'
    }
}

```

If you prefer not to use Grails' data binding but instead manually parse the incoming XML or JSON the controller action below:

```

def consume() {
    request.withFormat {
        xml {
            render "The XML Title Is ${request.XML.@title}."
        }
        json {
            render "The JSON Title Is ${request.JSON.title}."
        }
    }
}

```

To test the XML request you can specify the XML as a string:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test consume xml'() {
    when:
        request.xml = '<book title="The Stand"/>'
        controller.consume()

    then:
        response.text == 'The XML Title Is The Stand.'
}

void 'test consume json'() {
    when:
        request.json = '{title:"The Stand"}'
        controller.consume()

    then:
        response.text == 'The JSON Title Is The Stand.'
}
}

```

Testing Mime Type Handling

You can test mime type handling and the `withFormat` method quite simply by setting the request's con

```

// controller action
def sayHello() {
    def data = [Hello:"World"]
    request.withFormat {
        xml { render data as grails.converters.XML }
        json { render data as grails.converters.JSON }
        html data
    }
}

```

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test say hello xml'() {
    when:
        request.contentType = 'application/xml'
        controller.sayHello()

    then:
        response.text == '<?xml version="1.0" encoding="UTF-8"?><map><entry key="
    }
}

void 'test say hello json'() {
    when:
        request.contentType = 'application/json'
        controller.sayHello()

    then:
        response.text == '{"Hello": "World"}'
    }
}

```

There are constants provided by ControllerUnitTestMixin for all of the common content

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test say hello xml'() {
    when:
        request.contentType = XML_CONTENT_TYPE
        controller.sayHello()

    then:
        response.text == '<?xml version="1.0" encoding="UTF-8"?><map><entry key="
    }
}

void 'test say hello json'() {
    when:
        request.contentType = JSON_CONTENT_TYPE
        controller.sayHello()

    then:
        response.text == '{"Hello": "World"}'
    }
}

```

The defined constants are listed below:

Constant	Value
ALL_CONTENT_TYPE	/*
FORM_CONTENT_TYPE	application/x-www-form-urlencoded
MULTIPART_FORM_CONTENT_TYPE	multipart/form-data
HTML_CONTENT_TYPE	text/html
XHTML_CONTENT_TYPE	application/xhtml+xml
XML_CONTENT_TYPE	application/xml
JSON_CONTENT_TYPE	application/json
TEXT_XML_CONTENT_TYPE	text/xml
TEXT_JSON_CONTENT_TYPE	text/json
HAL_JSON_CONTENT_TYPE	application/hal+json
HAL_XML_CONTENT_TYPE	application/hal+xml
ATOM_XML_CONTENT_TYPE	application/atom+xml

Testing Duplicate Form Submissions

Testing duplicate form submissions is a little bit more involved. For example if you have an action that has

```
def handleForm() {
  withForm {
    render "Good"
  }.invalidToken {
    render "Bad"
  }
}
```

you want to verify the logic that is executed on a good form submission and the logic that is executed on a bad form submission is simple. Just invoke the controller:


```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test duplicate form submission'() {
    when:
        controller.handleForm()

    then:
        response.text == 'Bad'
    }
}

```

Testing the successful submission requires providing an appropriate SynchronizerToken:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

import org.codehaus.groovy.grails.web.servlet.mvc.SynchronizerTokensHolder

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test valid form submission'() {
    when:
        def tokenHolder = SynchronizerTokensHolder.store(session)

    params[SynchronizerTokensHolder.TOKEN_URI] = '/controller/handleForm'
    params[SynchronizerTokensHolder.TOKEN_KEY] =
        tokenHolder.generateToken(params[SynchronizerTokensHolder.TOKEN_URI])
    controller.handleForm()

    then:
        response.text == 'Good'
    }
}

```

If you test both the valid and the invalid request in the same test be sure to reset the response between exec

```

import grails.test.mixin.TestFor
import spock.lang.Specification

import org.codehaus.groovy.grails.web.servlet.mvc.SynchronizerTokensHolder

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test form submission'() {
    when:
        controller.handleForm()

    then:
        response.text == 'Bad'

    when:
        response.reset()
        def tokenHolder = SynchronizerTokensHolder.store(session)

    params[SynchronizerTokensHolder.TOKEN_URI] = '/controller/handleForm'
    params[SynchronizerTokensHolder.TOKEN_KEY] =
    tokenHolder.generateToken(params[SynchronizerTokensHolder.TOKEN_URI])
    controller.handleForm()

    then:
        response.text == 'Good'
    }
}

```

Testing File Upload

You use the `GrailsMockMultipartFile` class to test file uploads. For example consider the followin

```

def uploadFile() {
    MultipartFile file = request.getFile("myFile")
    file.transferTo(new File("/local/disk/myFile"))
}

```

To test this action you can register a `GrailsMockMultipartFile` with the request:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

import org.codehaus.groovy.grails.plugins.testing.GrailsMockMultipartFile

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

    void 'test file upload'() {
        when:
            def file = new GrailsMockMultipartFile('myFile', 'some file contents'.bytes)
            request.addFile file
            controller.uploadFile()

        then:
            file.targetFileLocation.path == '/local/disk/myFile'
    }
}

```

The `GrailsMockMultipartFile` constructor arguments are the name and contents of the file. It has a method that simply records the `targetFileLocation` and doesn't write to disk.

Testing Command Objects

Special support exists for testing command object handling with the `mockCommandObject` method. For

```

class SimpleController {
    def handleCommand(SimpleCommand simple) {
        if(simple.hasErrors()) {
            render 'Bad'
        } else {
            render 'Good'
        }
    }
}

class SimpleCommand {
    String name

    static constraints = {
        name blank: false
    }
}

```

To test this you mock the command object, populate it and then validate it as follows:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test valid command object'() {
    given:
        def simpleCommand = new SimpleCommand(name: 'Hugh')
        simpleCommand.validate()

    when:
        controller.handleCommand(simpleCommand)

    then:
        response.text == 'Good'
    }

void 'test invalid command object'() {
    given:
        def simpleCommand = new SimpleCommand(name: '')
        simpleCommand.validate()

    when:
        controller.handleCommand(simpleCommand)

    then:
        response.text == 'Bad'
    }
}

```

The testing framework also supports allowing Grails to create the command object instance automatically in the controller action method. Grails will create an instance of the command object, perform data binding on the object just like it does in when the application is running. See the test below.

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleController)
class SimpleControllerSpec extends Specification {

void 'test valid command object'() {
    when:
        params.name = 'Hugh'
        controller.handleCommand()

    then:
        response.text == 'Good'
    }

void 'test invalid command object'() {
    when:
        params.name = ''
        controller.handleCommand()

    then:
        response.text == 'Bad'
    }
}

```

Testing allowedMethods

The unit testing environment respects the [allowedMethods](#) property in controllers. If a controller action methods, the unit test must be constructed to deal with that.

```
// grails-app/controllers/com/demo/DemoController.groovy
package com.demo

class DemoController {

    static allowedMethods = [save: 'POST', update: 'PUT', delete: 'DELETE']

    def save() {
        render 'Save was successful!'
    }

    // ...
}
```

```
// test/unit/com/demo/DemoControllerSpec.groovy
package com.demo

import grails.test.mixin.TestFor
import spock.lang.Specification
import static javax.servlet.http.HttpServletResponse.*

@TestFor(DemoController)
class DemoControllerSpec extends Specification {

    void "test a valid request method"() {
        when:
            request.method = 'POST'
            controller.save()

        then:
            response.status == SC_OK
            response.text == 'Save was successful!'
    }

    void "test an invalid request method"() {
        when:
            request.method = 'DELETE'
            controller.save()

        then:
            response.status == SC_METHOD_NOT_ALLOWED
    }
}
```

Testing Calling Tag Libraries

You can test calling tag libraries using `ControllerUnitTestMethodMixin`, although the mechanism for t example to test a call to the message tag, add a message to the messageSource. Consider the followin

```
def showMessage() {  
    render g.message(code: "foo.bar")  
}
```

This can be tested as follows:

```
import grails.test.mixin.TestFor  
import spock.lang.Specification  
  
@TestFor(SimpleController)  
class SimpleControllerSpec extends Specification {  
  
    void 'test render message tag'() {  
        given:  
            messageSource.addMessage 'foo.bar', request.locale, 'Hello World'  
  
        when:  
            controller.showMessage()  
  
        then:  
            response.text == 'Hello World'  
    }  
}
```

See [unit testing tag libraries](#) for more information.

15.1.2 Unit Testing Tag Libraries

The Basics

Tag libraries and GSP pages can be tested with the `grails.test.mixin.web.GroovyPageUnit` which tag library is under test with the `TestFor` annotation:

```
import grails.test.mixin.TestFor  
import spock.lang.Specification  
  
@TestFor(SimpleTagLib)  
class SimpleTagLibSpec extends Specification {  
  
    void "test something"() {  
    }  
}
```

Adding the `TestFor` annotation to a `TagLib` class causes a new `tagLib` field to be automatically created. This field can be used to test calling tags as function calls. The return value of a function call is either a [Stream](#) or a `String` depending on the tag closure when [returnObjectForTags](#) feature is used.

Note that if you are testing invocation of a custom tag from a controller you can combine the `GroovyPageUnitTestMethodMixin` using the `Mock` annotation:

```
import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(SimpleController)
@Mock(SimpleTagLib)
class SimpleControllerSpec extends Specification {

}
```

Testing Custom Tags

The core Grails tags don't need to be enabled during testing, however custom tag libraries do. The `GroovyPageUnitTestMethodMixin` provides a `mockTagLib()` method that you can use to mock a custom tag library. For example consider the following:

```
class SimpleTagLib {

    static namespace = 's'

    def hello = { attrs, body ->
        out << "Hello ${attrs.name ?: 'World'}"
    }

    def bye = { attrs, body ->
        out << "Bye ${attrs.author.name ?: 'World'}"
    }

}
```

You can test this tag library by using `TestFor` and supplying the name of the tag library:

```

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleTagLib)
class SimpleTagLibSpec extends Specification {

    void "test hello tag"() {
        expect:
        applyTemplate('<s:hello />') == 'Hello World'
        applyTemplate('<s:hello name="Fred" />') == 'Hello Fred'
        applyTemplate('<s:bye author="${author}" />', [author: new Author(name: '
    }

    void "test tag calls"() {
        expect:
        tagLib.hello().toString() == 'Hello World'
        tagLib.hello(name: 'Fred').toString() == 'Hello Fred'
        tagLib.bye(author: new Author(name: 'Fred')).toString() == 'Bye Fred'
    }
}

```

Alternatively, you can use the `TestMixin` annotation and mock multiple tag libraries using the `mockTagLib` method.

```

import spock.lang.Specification
import grails.test.mixin.TestMixin
import grails.test.mixin.web.GroovyPageUnitTestMixin

@TestMixin(GroovyPageUnitTestMixin)
class MultipleTagLibSpec extends Specification {

    void "test multiple tags"() {
        given:
        mockTagLib(SomeTagLib)
        mockTagLib(SomeOtherTagLib)

        expect:
        // ...
    }
}

```

The `GroovyPageUnitTestMixin` provides convenience methods for asserting that the template output matches the expected output.


```
import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(SimpleTagLib)
class SimpleTagLibSpec extends Specification {

    void "test hello tag"() {
        expect:
        assertEquals ('Hello World', '<s:hello />')
        assertOutputMatches (/. *Fred.*/, '<s:hello name="Fred" />')
    }
}
```

Testing View and Template Rendering

You can test rendering of views and templates in `grails-app/views` via the `render(Map)` method:

```
import spock.lang.Specification
import grails.test.mixin.TestMixin
import grails.test.mixin.web.GroovyPageUnitTestMixin

@TestMixin(GroovyPageUnitTestMixin)
class RenderingSpec extends Specification {

    void "test rendering template"() {
        when:
        def result = render(template: '/simple/hello')

        then:
        result == 'Hello World!'
    }
}
```

This will attempt to render a template found at the location `grails-app/views/simple/_hello`. For custom tag libraries you need to call `mockTagLib` as described in the previous section.

Some core tags use the active controller and action as input. In `GroovyPageUnitTestMixin` tests, you can name by setting `controllerName` and `actionName` properties on the `webRequest` object:

```
webRequest.controllerName = 'simple'
webRequest.actionName = 'hello'
```

15.1.3 Unit Testing Domains

Overview

Domain class interaction can be tested without involving a real database connection using `DomainClassUnitTestMixin` and `HibernateTestMixin`.

The GORM implementation in `DomainClassUnitTestMixin` is using a simple in-memory ConcurrentHashMap, which has some limitations compared to a real GORM implementation.

A large, commonly-used portion of the GORM API can be mocked using `DomainClassUnitTestMixin` and `HibernateTestMixin`:

- Simple persistence methods like `save()`, `delete()` etc.
- Dynamic Finders
- Named Queries
- Query-by-example
- GORM Events

`HibernateTestMixin` uses Hibernate 4 and a H2 in-memory database. This makes it possible to use a real GORM implementation.

All features of GORM for Hibernate can be tested within a `HibernateTestMixin` unit test including:

- String-based HQL queries
- composite identifiers
- dirty checking methods
- any direct interaction with Hibernate

The implementation behind `HibernateTestMixin` takes care of setting up the Hibernate with the in-memory database and the given domain classes for use in a unit test. The `@Domain` annotation is used to tell which domain classes should be loaded.

DomainClassUnitTestMixin Basics

`DomainClassUnitTestMixin` is typically used in combination with testing either a controller, service, or a collaborator defined by the `Mock` annotation:

```
import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(BookController)
@Mock(Book)
class BookControllerSpec extends Specification {
    // ...
}
```

The example above tests the SimpleController class and mocks the behavior of the Simple domain scaffolded save controller action:

```
class BookController {
  def save() {
    def book = new Book(params)
    if (book.save(flush: true)) {
      flash.message = message(
        code: 'default.created.message',
        args: [message(code: 'book.label', default: 'Book'), book.id]
      )
      redirect(action: "show", id: book.id)
    }
    else {
      render(view: "create", model: [bookInstance: book])
    }
  }
}
```

Tests for this action can be written as follows:

```
import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(BookController)
@Mock(Book)
class BookControllerSpec extends Specification {
  void "test saving an invalid book"() {
    when:
      controller.save()

    then:
      model.bookInstance != null
      view == '/book/create'
  }

  void "test saving a valid book"() {
    when:
      params.title = "The Stand"
      params.pages = "500"

    controller.save()

    then:
      response.redirectedUrl == '/book/show/1'
      flash.message != null
      Book.count() == 1
  }
}
```

Mock annotation also supports a list of mock collaborators if you have more than one domain to mock:

```

import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(BookController)
@Mock([Book, Author])
class BookControllerSpec extends Specification {
    // ...
}

```

Alternatively you can also use the `DomainClassUnitTestMixin` directly with the `TestMixin` annotation to mock domains during your test:

```

import grails.test.mixin.TestFor
import grails.test.mixin.TestMixin
import spock.lang.Specification
import grails.test.mixin.domain.DomainClassUnitTestMixin

@TestFor(BookController)
@TestMixin(DomainClassUnitTestMixin)
class BookControllerSpec extends Specification {

    void setupSpec() {
        mockDomain(Book)
    }

    void "test saving an invalid book"() {
        when:
            controller.save()

        then:
            model.bookInstance != null
            view == '/book/create'
    }

    void "test saving a valid book"() {
        when:
            params.title = "The Stand"
            params.pages = "500"

        controller.save()

        then:
            response.redirectedUrl == '/book/show/1'
            flash.message != null
            Book.count() == 1
    }
}

```

The `mockDomain` method also includes an additional parameter that lets you pass a Map of Maps to contain data:

```
mockDomain(Book, [
    [title: "The Stand", pages: 1000],
    [title: "The Shining", pages: 400],
    [title: "Along Came a Spider", pages: 300] ])
```

Testing Constraints

There are 3 types of validateable classes:

1. Domain classes
2. Classes which implement the `Validateable` trait
3. Command Objects which have been made validateable automatically

These are all easily testable in a unit test with no special configuration necessary as long as the test method uses the `GrailsUnitTestMixin` using `TestMixin`. See the examples below.

```
// src/groovy/com/demo/MyValidateable.groovy
package com.demo

class MyValidateable implements grails.validation.Validateable {
    String name
    Integer age

    static constraints = {
        name matches: /[A-Z].*/
        age range: 1..99
    }
}
```

```
// grails-app/domain/com/demo/Person.groovy
package com.demo

class Person {
    String name

    static constraints = {
        name matches: /[A-Z].*/
    }
}
```

```
// grails-app/controllers/com/demo/DemoController.groovy
package com.demo

class DemoController {
    def addItem(MyCommandObject co) {
        if(co.hasErrors()) {
            render 'something went wrong'
        } else {
            render 'items have been added'
        }
    }
}

class MyCommandObject {
    Integer numberOfItems

    static constraints = {
        numberOfItems range: 1..10
    }
}
```

```
// test/unit/com/demo/PersonSpec.groovy
package com.demo

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(Person)
class PersonSpec extends Specification {

    void "Test that name must begin with an upper case letter"() {
        when: 'the name begins with a lower letter'
            def p = new Person(name: 'jeff')

        then: 'validation should fail'
            !p.validate()

        when: 'the name begins with an upper case letter'
            p = new Person(name: 'Jeff')

        then: 'validation should pass'
            p.validate()
    }
}
```

```
// test/unit/com/demo/DemoControllerSpec.groovy
package com.demo

import grails.test.mixin.TestFor
import spock.lang.Specification

@TestFor(DemoController)
class DemoControllerSpec extends Specification {

void 'Test an invalid number of items'() {
    when:
        params.numberOfItems = 42
        controller.addItem()

    then:
        response.text == 'something went wrong'
}

void 'Test a valid number of items'() {
    when:
        params.numberOfItems = 8
        controller.addItem()

    then:
        response.text == 'items have been added'
}
}
```

```

// test/unit/com/demo/MyValidateableSpec.groovy
package com.demo

import grails.test.mixin.TestMixin
import grails.test.mixin.support.GrailsUnitTestMixin
import spock.lang.Specification

@TestMixin(GrailsUnitTestMixin)
class MyValidateableSpec extends Specification {

void 'Test validate can be invoked in a unit test with no special configuration'(
    when: 'an object is valid'
    def validateable = new MyValidateable(name: 'Kirk', age: 47)

then: 'validate() returns true and there are no errors'
    validateable.validate()
    !validateable.hasErrors()
    validateable.errors.errorCount == 0

when: 'an object is invalid'
    validateable.name = 'kirk'

then: 'validate() returns false and the appropriate error is created'
    !validateable.validate()
    validateable.hasErrors()
    validateable.errors.errorCount == 1
    validateable.errors['name'].code == 'matches.invalid'

when: 'the clearErrors() is called'
    validateable.clearErrors()

then: 'the errors are gone'
    !validateable.hasErrors()
    validateable.errors.errorCount == 0

when: 'the object is put back in a valid state'
    validateable.name = 'Kirk'

then: 'validate() returns true and there are no errors'
    validateable.validate()
    !validateable.hasErrors()
    validateable.errors.errorCount == 0
    }
}

```



```
// test/unit/com/demo/MyCommandObjectSpec.groovy
package com.demo

import grails.test.mixin.TestMixin
import grails.test.mixin.support.GrailsUnitTestMixin
import spock.lang.Specification

@TestMixin(GrailsUnitTestMixin)
class MyCommandObjectSpec extends Specification {

void 'Test that numberOfItems must be between 1 and 10'() {
    when: 'numberOfItems is less than 1'
        def co = new MyCommandObject()
        co.numberOfItems = 0

    then: 'validation fails'
        !co.validate()
        co.hasErrors()
        co.errors['numberOfItems'].code == 'range.toosmall'

    when: 'numberOfItems is greater than 10'
        co.numberOfItems = 11

    then: 'validation fails'
        !co.validate()
        co.hasErrors()
        co.errors['numberOfItems'].code == 'range.toobig'

    when: 'numberOfItems is greater than 1'
        co.numberOfItems = 1

    then: 'validation succeeds'
        co.validate()
        !co.hasErrors()

    when: 'numberOfItems is greater than 10'
        co.numberOfItems = 10

    then: 'validation succeeds'
        co.validate()
        !co.hasErrors()
    }
}
```

That's it for testing constraints. One final thing we would like to say is that testing the constraints in the "constraints" property name which is a mistake that is easy to make and equally easy to overlook. A problem straight away.

HibernateTestMixin Basics

HibernateTestMixin allows Hibernate 4 to be used in Grails unit tests. It uses a H2 in-memory database.

```

import grails.test.mixin.TestMixin
import grails.test.mixin.gorm.Domain
import grails.test.mixin.hibernate.HibernateTestMixin
import spock.lang.Specification

@Domain(Person)
@TestMixin(HibernateTestMixin)
class PersonSpec extends Specification {

    void "Test count people"() {
        expect: "Test execute Hibernate count query"
            Person.count() == 0
            sessionFactory != null
            transactionManager != null
            hibernateSession != null
    }
}

```

This library dependency is required in build.gradle for adding support for HibernateTestMixin.

```

dependencies {
    testCompile 'org.grails:grails-datastore-test-support:4.0.4.RELEASE'
}

```

HibernateTestMixin is only supported with hibernate4 plugin versions $\geq 4.3.8.1$.

```

dependencies {
    compile "org.grails.plugins:hibernate:4.3.8.1"
}

```

Configuring domain classes for HibernateTestMixin tests

The `grails.test.mixin.gorm.Domain` annotation is used to configure the list of domain class instances that gets configured when the unit test runtime is initialized.

Domain annotations will be collected from several locations:

- the annotations on the test class
- the package annotations in the package-info.java/package-info.groovy file in the package of the test class
- each super class of the test class and their respective package annotations
- the possible [SharedRuntime](#) class

Domain annotations can be shared by adding them as package annotations to package-info.java/package-info.groovy file in the package of the test class. The [SharedRuntime](#) class which has been added for the test.

It's not possible to use DomainClassUnitTestMethodMixin's `Mock` annotation in HibernateTestMixin tests. Use the `Mock` annotation in HibernateTestMixin tests.

15.1.4 Unit Testing Filters

Unit testing filters is typically a matter of testing a controller where a filter is a mock collaborator. For example,

```
class CancellingFilters {
    def filters = {
        all(controller:"simple", action:"list") {
            before = {
                redirect(controller:"book")
                return false
            }
        }
    }
}
```

This filter intercepts the `list` action of the `simple` controller and redirects to the `book` controller. The test targets the `SimpleController` class and adds the `CancellingFilters` as a mock collaborator:

```
import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(SimpleController)
@Mock(CancellingFilters)
class SimpleControllerSpec extends Specification {

    // ...
}
```

You can then implement a test that uses the `withFilters` method to wrap the call to an action in filter e

```

import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(SimpleController)
@Mock(CancellingFilters)
class SimpleControllerSpec extends Specification {

    void "test list action is filtered"() {
        when:
            withFilters(action:"list") {
                controller.list()
            }

        then:
            response.redirectedUrl == '/book'
    }
}

```

Note that the `action` parameter is required because it is unknown what the action to invoke is until the `withFilters` parameter is optional and taken from the controller under test. If it is another controller you are testing then

```

withFilters(controller:"book",action:"list") {
    controller.list()
}

```

15.1.5 Unit Testing URL Mappings

The Basics

Testing URL mappings can be done with the `TestFor` annotation testing a particular URL mapping; for other URL mappings you can do the following:


```

import com.demo.SimpleController
import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(UrlMappings)
@Mock(SimpleController)
class UrlMappingsSpec extends Specification {
    // ...
}

```

As you can see, any controller that is the target of a URL mapping that you're testing *must* be added to the

 Note that since the default `UrlMappings` class is in the default package your test must also

With that done there are a number of useful methods that are defined by the `grails.test.mixin` testing URL mappings. These include:

- `assertForwardUrlMapping` - Asserts a URL mapping is forwarded for the given controller class (a mock collaborate for this to work)
- `assertReverseUrlMapping` - Asserts that the given URL is produced when reverse mapping a
- `assertUrlMapping` - Asserts a URL mapping is valid for the given URL. This combines `assertReverseUrlMapping` assertions

Asserting Forward URL Mappings

You use `assertForwardUrlMapping` to assert that a given URL maps to a given controller. For example:

```
static mappings = {
    "/actionOne"(controller: "simple", action: "action1")
    "/actionTwo"(controller: "simple", action: "action2")
}
```

The following test can be written to assert these URL mappings:

```
import com.demo.SimpleController
import grails.test.mixin.TestFor
import grails.test.mixin.Mock
import spock.lang.Specification

@TestFor(UrlMappings)
@Mock(SimpleController)
class UrlMappingsSpec extends Specification {

    void "test forward mappings"() {
        expect:
        assertForwardUrlMapping("/actionOne", controller: 'simple', action: 'action1')
        assertForwardUrlMapping("/actionTwo", controller: 'simple', action: 'action2')
    }
}
```

Assert Reverse URL Mappings

You use `assertReverseUrlMapping` to check that correct links are produced for your URL mapping. An example test is largely identical to the previous listing except you use `assertReverseUrlMapping`. Note that you can combine these 2 assertions with `assertUrlMapping`.

15.1.6 Mocking Collaborators

The Spock Framework manual has a chapter on [Interaction Based Testing](#) which also explains mocking collaborators.

15.1.7 Mocking Codecs

The `GrailsUnitTestMethodMixin` provides a `mockCodec` method for mocking [custom codecs](#) which may

```
mockCodec(MyCustomCodec)
```

Failing to mock a codec which is invoked while a unit test is running may result in a `MissingMethodException`.

15.1.8 Unit Test Metaprogramming

If runtime metaprogramming needs to be done in a unit test it needs to be done early in the process before the unit test class is being initialized. For a Spock based test this should be done in a method marked with `@BeforeClass`.

```
package myapp

import grails.test.mixin.*
import spock.lang.Specification

@TestFor(SomeController)
class SomeControllerSpec extends Specification {

    def setupSpec() {
        SomeClass.metaClass.someMethod = { ->
            // do something here
        }
    }

    // ...
}
```

```

package myapp

import grails.test.mixin.*
import org.junit.*

@TestFor(SomeController)
class SomeControllerTests {

    @BeforeClass
    static void metaProgramController() {
        SomeClass.metaClass.someMethod = { ->
            // do something here
        }
    }

    // ...
}

```

15.2 Integration Testing

Integration tests differ from unit tests in that you have full access to the Grails environment within the [create-integration-test](#) command:

```
$ grails create-integration-test Example
```

The above command will create a new integration test at the location `src/integration-test/groovy`. Grails uses the test environment for integration tests and loads the application prior to the first test run. All

Transactions

Integration tests run inside a database transaction by default, which is rolled back at the end of the each test. Only data that is persisted to the database (which is shared across all tests). The default generated integration test template is

```

import grails.test.mixin.integration.Integration
import grails.transaction.*
import spock.lang.*

@Integration
@Rollback
class artifact.nameSpec extends Specification {

    ...

    void "test something"() {
        expect:"fix me"
            true == false
    }
}

```

The Rollback annotation ensures that each test methods runs in a transaction that is rolled back. Generate your tests depending on order or application state.

Using Spring's Rollback annotation

In Grails 3.0 tests rely on `grails.transaction.Rollback` annotation to bind the session in integration and `setupSpec()` method in the test is run prior to the transaction starting hence you would see No running integration test if `setup()` sets up data and persists them as shown in the below sample:

```

import grails.test.mixin.integration.Integration
import grails.transaction.*
import spock.lang.*

@Integration
@Rollback
class artifact.nameSpec extends Specification {

    void setup() {
        // Below line would throw a Hibernate session not found error
        new Book(name: 'Grails in Action').save(flush: true)
    }

    void "test something"() {
        expect:
            Book.count() == 1
    }
}

```

To make sure the setup logic runs within the transaction you have to move it to be called from the method shown below:


```

import grails.test.mixin.integration.Integration
import grails.transaction.*
import spock.lang.*

@Integration
@Rollback
class artifact.nameSpec extends Specification {

void setupData() {
    new Book(name: 'Grails in Action').save(flush: true)
}

void "test something"() {
    given:
        setupData()

    expect:
        Book.count() == 1
}
}

```

Another approach could be to use Spring's [@Rollback](#) instead.

```

import grails.test.mixin.integration.Integration
import org.springframework.test.annotation.Rollback
import spock.lang.*

@Integration
@Rollback
class artifact.nameSpec extends Specification {

void setup() {
    new Book(name: 'Grails in Action').save(flush: true)
}

void "test something"() {
    expect:
        Book.count() == 1
}
}

```



It isn't possible to make `grails.transaction.Rollback` behave the same way as `grails.transaction.Rollback` transforms the byte code of the class, eliminating the `@Rollback` annotation (which Spring's version requires). This has the downside that you cannot implement it differently than Spring does for testing).

DirtyContext

If you do have a series of tests that will share state you can remove the `@Rollback` and the last test annotation which will shutdown the environment and restart it fresh (note that this will have an impact on t

Autowiring

To obtain a reference to a bean you can use the [Autowired](#) annotation. For example:

```
...
import org.springframework.beans.factory.annotation.*

@Integration
@Rollback
class artifact.nameSpec extends Specification {

    @Autowired
    ExampleService exampleService
    ...

    void "Test example service"() {
        expect:
            exampleService.countExamples() == 0
    }
}
```

Testing Controllers

To integration test controllers it is recommended you use [create-functional-test](#) command to create a G functional testing for more information.

15.3 Functional Testing

Functional tests involve making HTTP requests against the running application and verifying the resultant from the integration phase in that the Grails application is now listening and responding to actual HTTP scenarios, such as making REST calls against a JSON API.

Grails by default ships with support for writing functional tests using the [Geb framework](#). To create-functional-test command which will create a new functional test:

```
$ grails create-functional-test MyFunctional
```

The above command will create a new Spock spec called `MyFunctionalSpec.groovy` in the `src/integrationTest` test is annotated with the [Integration](#) annotation to indicate it is a integration test and extends the `GebSpec`

```

@Integration
class HomeSpec extends GebSpec {

  def setup() {
  }

  def cleanup() {
  }

  void "Test the home page renders correctly"() {
    when: "The home page is visited"
    go '/'

    then: "The title is correct"
        $('title').text() == "Welcome to Grails"
  }
}

```

When the test is run the application container will be loaded up in the background and you can send requests.

Note that the application is only loaded once for the entire test run, so functional tests share the state of the application.

In addition the application is loaded in the JVM as the test, this means that the test has full access to the application's data services such as GORM to setup and cleanup test data.

The `Integration` annotation supports an optional `applicationClass` attribute which may be used to specify the application class for the functional test. The class must extend [GrailsAutoConfiguration](#).

```

@Integration(applicationClass=com.demo.Application)
class HomeSpec extends GebSpec {

  // ...

}

```

If the `applicationClass` is not specified then the test runtime environment will attempt to locate the application class. This can be problematic in multiproject builds where multiple application classes may be present.

16 Internationalization

Grails supports Internationalization (i18n) out of the box by leveraging the underlying Spring MVC intern to customize the text that appears in a view based on the user's Locale. To quote the javadoc for the [Locale](#)

A Locale object represents a specific geographical, political, or cultural region. An operation that is called locale-sensitive and uses the Locale to tailor information for the user. For example, displaying a number--the number should be formatted according to the customs/conventions of the user's native language.

A Locale is made up of a [language code](#) and a [country code](#). For example "en_US" is the code for US English.

16.1 Understanding Message Bundles

Now that you have an idea of locales, to use them in Grails you create message bundle files containing text. Message bundles in Grails are located inside the `grails-app/i18n` directory and are simple Java properties files.

Each bundle starts with the name `messages` by convention and ends with the locale. Grails ships with several bundles within the `grails-app/i18n` directory. For example:

- `messages.properties`
- `messages_da.properties`
- `messages_de.properties`
- `messages_es.properties`
- `messages_fr.properties`
- ...

By default Grails looks in `messages.properties` for messages unless the user has specified a locale. To change the locale, simply create a new properties file that ends with the locale you are interested in. For example `messages_de.properties`.

16.2 Changing Locales

By default the user locale is detected from the incoming `Accept-Language` header. However, you can manually specify a locale by passing a parameter called `lang` to Grails as a request parameter:

```
/book/list?lang=es
```

Grails will automatically switch the user's locale and store it in a cookie so subsequent requests will have the same locale.

16.3 Reading Messages

Reading Messages in the View

The most common place that you need messages is inside the view. Use the [message](#) tag for this:

```
<g:message code="my.localized.content" />
```

As long as you have a key in your `messages.properties` (with appropriate locale suffix) such message:

```
my.localized.content=Hola, Me llamo John. Hoy es domingo.
```

Messages can also include arguments, for example:

```
<g:message code="my.localized.content" args="${ ['Juan', 'lunes'] }" />
```

The message declaration specifies positional parameters which are dynamically specified:

```
my.localized.content=Hola, Me llamo {0}. Hoy es {1}.
```

Reading Messages in Controllers and Tag Libraries

It's simple to read messages in a controller since you can invoke tags as methods:

```
def show() {  
    def msg = message(code: "my.localized.content", args: ['Juan', 'lunes'])  
}
```

The same technique can be used in [tag libraries](#), but if your tag library uses a custom [namespace](#) then you need to use the `namespace` attribute.

```
def myTag = { attrs, body ->
  def msg = g.message(code: "my.localized.content", args: ['Juan', 'lunes'])
}
```

16.4 Scaffolding and i18n

Grails [scaffolding](#) templates for controllers and views are fully i18n-aware. The GSPs use the [message](#) tag to resolve locale-specific messages.

The scaffolding includes locale specific labels for domain classes and domain fields. For example, if you have a domain class like this:

```
class Book {
  String title
}
```

The scaffolding will use labels with the following keys:

```
book.label = Libro
book.title.label = Ttulo del libro
```

You can use this property pattern if you'd like or come up with one of your own. There is nothing special about it other than it's the convention used by the scaffolding.

17 Security

Grails is no more or less secure than Java Servlets. However, Java servlets (and hence Grails) are extremely vulnerable to overflow and malformed URL exploits due to the nature of the Java Virtual Machine underpinning the code.

Web security problems typically occur due to developer naivety or mistakes, and there is a little Grails writing secure applications easier to write.

What Grails Automatically Does

Grails has a few built in safety mechanisms by default.

1. All standard database access via [GORM](#) domain objects is automatically SQL escaped to prevent SQL injection.
2. The default [scaffolding](#) templates HTML escape all data fields when displayed
3. Grails link creating tags ([link](#), [form](#), [createLink](#), [createLinkTo](#) and others) all use appropriate escaping
4. Grails provides [codecs](#) to let you trivially escape data when rendered as HTML, JavaScript and URLs

17.1 Securing Against Attacks

SQL injection

Hibernate, which is the technology underlying GORM domain classes, automatically escapes data when rendered. However it is still possible to write bad dynamic HQL code that uses unchecked request parameters. For example, the following HQL injection attacks:

```
def vulnerable() {  
    def books = Book.find("from Book as b where b.title='" + params.title + "'")  
}
```

or the analogous call using a GString:

```
def vulnerable() {  
    def books = Book.find("from Book as b where b.title='${params.title}')"  
}
```

Do **not** do this. Use named or positional parameters instead to pass in parameters:

```
def safe() {  
  def books = Book.find("from Book as b where b.title = ?",  
                        [params.title])  
}
```

or

```
def safe() {  
  def books = Book.find("from Book as b where b.title = :title",  
                        [title: params.title])  
}
```

Phishing

This really a public relations issue in terms of avoiding hijacking of your branding and a declared community need to know how to identify valid emails.

XSS - cross-site scripting injection

It is important that your application verifies as much as possible that incoming requests were originated from a trusted source. It is also important to ensure that all data values rendered into views are escaped correctly. For example, you should ensure that people cannot maliciously inject JavaScript or other HTML into data or tags viewed by others.

Grails 2.3 and above include special support for automatically encoded data placed into GSP pages. See the [prevention](#) for further information.

You must also avoid the use of request parameters or data fields for determining the next URL to redirect to. For example, if you use a request parameter for example to determine where to redirect a user to after a successful login, attackers can imitate the user and then redirect the user back to their own site once logged in, potentially allowing JavaScript code to then execute.

Cross-site request forgery

CSRF involves unauthorized commands being transmitted from a user that a website trusts. A typical example is an attacker performing an action on your website if the user is still authenticated.

The best way to decrease risk against these types of attacks is to use the `useToken` attribute on your form elements. For more information on how to use it. An additional measure would be to not use remember-me cookies.

HTML/URL injection

This is where bad data is supplied such that when it is later used to create a link in a page, clicking it will redirect to another site or alter request parameters.

HTML/URL injection is easily handled with the [codecs](#) supplied by Grails, and the tag libraries support appropriate. If you create your own tags that generate URLs you will need to be mindful of doing this too.

Denial of service

Load balancers and other appliances are more likely to be useful here, but there are also issues relating to created by an attacker to set the maximum value of a result set so that a query could exceed the memory limit. The solution here is to always sanitize request parameters before passing them to dynamic finders or other GORM methods.

```
int limit = 100
def safeMax = Math.min(params.max?.toInteger() ?: limit, limit) // limit to 100 or less
return Book.list(max:safeMax)
```

Guessable IDs

Many applications use the last part of the URL as an "id" of some object to retrieve from GORM or elsewhere. These are easily guessable as they are typically sequential integers.

Therefore you must assert that the requesting user is allowed to view the object with the requested id before retrieving it.

Not doing this is "security through obscurity" which is inevitably breached, just like having a default password.

You must assume that every unprotected URL is publicly accessible one way or another.

17.2 Cross Site Scripting (XSS) Prevention

Cross Site Scripting (XSS) attacks are a common attack vector for web applications. They typically involve injecting malicious code into a web page. When that code is displayed, the browser does something nasty. It could be as simple as popping an alert box. The solution is to escape all untrusted user input when it is displayed in a page. For example,

```
<script>alert('Got ya!');</script>
```

will become

```
&lt;script&gt;alert('Got ya!');&lt;/script&gt;
```

when rendered, nullifying the effects of the malicious input.

By default, Grails plays it safe and escapes all content in `${ }` expressions in GSPs. All the standard C relevant attribute values.

So what happens when you want to stop Grails from escaping some content? There are valid use cases for it as-is, as long as that content is **trusted**. In such cases, you can tell Grails that the content is safe as should

```
<section>${raw(page.content)}</section>
```

The `raw()` method you see here is available from controllers, tag libraries and GSP pages.

XSS prevention is hard and requires a lot of developer attention



Although Grails plays it safe by default, that is no guarantee that your application will be attack. Such an attack is less likely to succeed than would otherwise be the case, but developers of potential attack vectors and attempt to uncover vulnerabilities in the application during test an unsafe default, thereby increasing the risk of a vulnerability being introduced.

There are more details about the XSS in [OWASP - XSS prevention rules](#) and [OWASP - Types of Cross-Reflected XSS](#) and [DOM based XSS](#). [DOM based XSS prevention](#) is coming more important because of the and Single Page Apps.

Grails codecs are mainly for preventing stored and reflected XSS type of attacks. Grails 2.4 includes HTML based XSS attacks.

It's difficult to make a solution that works for everyone, and so Grails provides a lot of flexibility with regard to you to keep most of your application safe while switching off default escaping or changing the codec used

Configuration

It is recommended that you review the configuration of a newly created Grails application to garner an und

GSP features the ability to automatically HTML encode GSP expressions, and as of Grails 2.3 this is the (found in `application.yml`) for a newly created Grails application can be seen below:

```
grails:
  views:
    gsp:
      encoding: UTF-8
      htmlcodec: xml # use xml escaping instead of HTML4 escaping
      codecs:
        expression: html # escapes values inside ${}
        scriptlets: html # escapes output from scriptlets in GSPs
        taglib: none # escapes output from taglibs
        staticparts: none # escapes output from static template parts
```

GSP features several codecs that it uses when writing the page to the response. The codecs are configured in `application.gsp`.

- `expression` - The expression codec is used to encode any code found within `${..}` expressions. The default is `html`.
- `scriptlet` - Used for output from GSP scriptlets (`<% %>`, `<%= %>` blocks). The default for newly created applications is `html`.
- `taglib` - Used to encode output from GSP tag libraries. The default is `none` for new application. The author can define the encoding of a given tag and by specifying `none` Grails remains backwards compatible.
- `staticparts` - Used to encode the raw markup output by a GSP page. The default is `none`.

Double Encoding Prevention

Versions of Grails prior to 2.3, included the ability to set the default codec to `html`, however enabling this would cause double encoding of the output using existing plugins due to encoding being applied twice (once by the `html` codec and then again if the plugin also encoded the output).

Grails 2.3 includes double encoding prevention so that when an expression is evaluated, it will not encode the output. For example, `${foo.encodeAsHTML() }` will not be encoded.

Raw Output

If you are 100% sure that the value you wish to present on the page has not been received from user input then you can use the `raw` method:

```
${raw(book.title)}
```

The 'raw' method is available in tag libraries, controllers and GSP pages.

Per Plugin Encoding

Grails also features the ability to control the codecs used on a per plugin basis. For example if you have the following configuration in your `application.groovy` will disable encoding for only the `foo` plugin

```
foo.grails.views.gsp.codecs.expression = "none"
```

Per Page Encoding

You can also control the various codecs used to render a GSP page on a per page basis, using a page directive.

```
<%@page expressionCodec="none" %>
```

Per Tag Library Encoding

Each tag library created has the opportunity to specify a default codec used to encode output from the tag library.

```
static defaultEncodeAs = 'html'
```

Encoding can also be specified on a per tag basis using "encodeAsForTags":

```
static encodeAsForTags = [tagName: 'raw']
```

Context Sensitive Encoding Switching

Certain tags require certain encodings and Grails features the ability to enable a codec only a certain part of the page. Consider for example the "<g:javascript>" tag which allows you to embed JavaScript code in the page without HTML coding for the execution of the body of the tag (but not for the markup that is output):

```
out.println '<script type="text/javascript">'
    withCodec("JavaScript") {
        out << body()
    }
out.println()
out.println '</script>'
```

Forced Encoding for Tags

If a tag specifies a default encoding that differs from your requirements you can force the encoding for a specific tag by using the "forceEncoding" attribute:

```
<g:message code="foo.bar" encodeAs="JavaScript" />
```

Default Encoding for All Output

The default configuration for new applications is fine for most use cases, and backwards compatible with . You can also make your application even more secure by configuring Grails to always encode all output at the `filteringCodecForContentType` configuration in `application.groovy`:

```
grails.views.gsp.filteringCodecForContentType.'text/html' = 'html'
```

Note that, if activated, the `staticparts` codec typically needs to be set to `raw` so that static markup is not encoded.

```
codecs {
    expression = 'html' // escapes values inside ${}
    scriptlet = 'html' // escapes output from scriptlets in GSPs
    taglib = 'none' // escapes output from taglibs
    staticparts = 'raw' // escapes output from static template parts
}
```

17.3 Encoding and Decoding Objects

Grails supports the concept of dynamic encode/decode methods. A set of standard codecs are bundled with Grails, and there is a mechanism for developers to contribute their own codecs that will be recognized at runtime.

Codec Classes

A Grails codec class is one that may contain an encode closure, a decode closure or both. When a Grails application starts, the framework dynamically loads codecs from the `grails-app/utils/` directory.

The framework looks under `grails-app/utils/` for class names that end with the convention `Codec`. The first codec that ships with Grails is `HTMLCodec`.

If a codec contains an encode closure Grails will create a dynamic encode method and add that method to the codec that defined the encode closure. For example, the `HTMLCodec` class defines an encode method `encodeAsHTML`.

The `HTMLCodec` and `URLCodec` classes also define a `decode` closure, so Grails attaches those with respectively. Dynamic codec methods may be invoked from anywhere in a Grails application. For example, a property called 'description' which may contain special characters that must be escaped to be presented in a GSP is to encode the description property using the dynamic `encode` method as shown below:

```
${report.description.encodeAsHTML() }
```

Decoding is performed using `value.decodeHTML()` syntax.

Encoder and Decoder interfaces for statically compiled code

A preferred way to use codecs is to use the `codecLookup` bean to get hold of `Encoder` and `Decoder` instances.

```
package org.grails.encoder;

public interface CodecLookup {
    public Encoder lookupEncoder(String codecName);
    public Decoder lookupDecoder(String codecName);
}
```

example of using `CodecLookup` and `Encoder` interface

```
import org.grails.encoder.CodecLookup

class CustomTagLib {
    CodecLookup codecLookup

    def myTag = { Map attrs, body ->
        out << codecLookup.lookupEncoder('HTML').encode(attrs.something)
    }
}
```

Standard Codecs

HTMLCodec

This codec performs HTML escaping and unescaping, so that values can be rendered safely in an HTML document without damaging the page layout. For example, given a value "Don't you know that 2 > 1?" you wouldn't be able to use it in an HTML document because the `>` will look like it closes a tag, which is especially bad if you render this data within an attribute value.

Example of usage:

```
<input name="comment.message" value="\${comment.message.encodeAsHTML()}" />
```



Note that the HTML encoding does not re-encode apostrophe/single quote so you must use double quotes for values to avoid text with apostrophes affecting your page.

HTMLCodec defaults to HTML4 style escaping (legacy HTMLCodec implementation in Grails versions before 2.0).

You can use plain XML escaping instead of HTML4 escaping by setting this config property in application.yml:

```
grails.views.gsp.htmlcodec = 'xml'
```

XMLCodec

This codec performs XML escaping and unescaping. It escapes & , < , > , " , ' , \ , @ , ` , non breaking space (\u00A0) and paragraph separator (\u2029).

HTMLJSCodec

This codec performs HTML and JS encoding. It is used for preventing some DOM-XSS vulnerabilities. See [OWASP XSS Prevention Cheat Sheet](#) for guidelines of preventing DOM based XSS attacks.

URLCodec

URL encoding is required when creating URLs in links or form actions, or any time data is used to create a URL. If you don't encode, you're getting into the URL and changing its meaning, for example "Apple & Blackberry" is not going to work. The & ampersand will break parameter parsing.

Example of usage:

```
<a href="/mycontroller/find?searchKey=\${lastSearch.encodeAsURL()}">  
Repeat last search  
</a>
```

Base64Codec

Performs Base64 encode/decode functions. Example of usage:

```
Your registration code is: ${user.registrationCode.encodeAsBase64()}
```

JavaScriptCodec

Escapes Strings so they can be used as valid JavaScript strings. For example:

```
Element.update('${elementId}',  
    '${render(template: "/common/message").encodeAsJavaScript()}')
```

HexCodec

Encodes byte arrays or lists of integers to lowercase hexadecimal strings, and can decode hexadecimal strings.

```
Selected colour: #${[255,127,255].encodeAsHex()}
```

MD5Codec

Uses the MD5 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in default system charset).
Example of usage:

```
Your API Key: ${user.uniqueID.encodeAsMD5()}
```

MD5BytesCodec

Uses the MD5 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in default system charset).

```
byte[] passwordHash = params.password.encodeAsMD5Bytes()
```


SHA1Codec

Uses the SHA1 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in default system charset). Example of usage:

```
Your API Key: ${user.uniqueID.encodeAsSHA1() }
```

SHA1BytesCodec

Uses the SHA1 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in default system charset). Example of usage:

```
byte[] passwordHash = params.password.encodeAsSHA1Bytes()
```

SHA256Codec

Uses the SHA256 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in default system charset). Example of usage:

```
Your API Key: ${user.uniqueID.encodeAsSHA256() }
```

SHA256BytesCodec

Uses the SHA256 algorithm to digest byte arrays or lists of integers, or the bytes of a string (in default system charset). Example of usage:

```
byte[] passwordHash = params.password.encodeAsSHA256Bytes()
```

Custom Codecs

Applications may define their own codecs and Grails will load them along with the standard codecs. `grails-app/utils/` directory and the class name must end with `Codec`. The codec may contain a `static` closure or both. The closure must accept a single argument which will be the object that the dynamic method

```
class PigLatinCodec {
    static encode = { str ->
        // convert the string to pig latin and return the result
    }
}
```

With the above codec in place an application could do something like this:

```
${lastName.encodeAsPigLatin()}
```

17.4 Authentication

Grails has no default mechanism for authentication as it is possible to implement authentication in many ways. A simple authentication mechanism using [interceptors](#). This is sufficient for simple use cases but it's hard to integrate with a framework, for example by using the [Spring Security](#) or the [Shiro](#) plugin.

Interceptors let you apply authentication across all controllers or across a URI space. For example you can create a `grails-app/controllers/SecurityInterceptor.groovy` by running:

```
grails create-interceptor security
```

and implement your interception logic there:

```

class SecurityInterceptor {
  SecurityInterceptor() {
    matchAll()
    .except(controller:'user', action:'login')
  }
  boolean before() {
    if (!session.user && actionName != "login") {
      redirect(controller: "user", action: "login")
      return false
    }
    return true
  }
}

```

Here the interceptor intercepts execution *before* all actions except login are executed, and if there is no action.

The login action itself is simple too:

```

def login() {
  if (request.get) {
    return // render the login view
  }
  def u = User.findByLogin(params.login)
  if (u) {
    if (u.password == params.password) {
      session.user = u
      redirect(action: "home")
    }
    else {
      render(view: "login", model: [message: "Password incorrect"])
    }
  }
  else {
    render(view: "login", model: [message: "User not found"])
  }
}

```

17.5 Security Plugins

If you need more advanced functionality beyond simple authentication such as authorization, roles etc. the security plugins.

17.5.1 Spring Security

The Spring Security plugins are built on the [Spring Security](#) project which provides a flexible, extensible authentication and authorization schemes. The plugins are modular so you can install just the functionality you need. The Spring Security plugins are the official security plugins for Grails and are actively maintained and supported.

There is a [Core plugin](#) which supports form-based authentication, encrypted/salted passwords, HTTP Basic authentication, and a plugin providing [user interface extensions](#) and security workflows.

See the [Core plugin page](#) for basic information and the [user guide](#) for detailed information.

17.5.2 Shiro

[Shiro](#) is a Java POJO-oriented security framework that provides a default domain model that models real roles. An example below:

```
class ExampleController extends JsecAuthBase {
    static accessControl = {
        // All actions require the 'Observer' role.
        role(name: 'Observer')

        // The 'edit' action requires the 'Administrator' role.
        role(name: 'Administrator', action: 'edit')

        // Alternatively, several actions can be specified.
        role(name: 'Administrator', only: [ 'create', 'edit', 'save', 'update' ])
    }
    ...
}
```

For more information on the Shiro plugin refer to the [documentation](#).

18 Plugins

Grails is first and foremost a web application framework, but it is also a platform. By exposing a number from the command line interface to the runtime configuration engine, Grails can be customised to suit all you need to do is create a plugin.

Extending the platform may sound complicated, but plugins can range from trivially simple to incredible application, you'll know how to create a plugin for [sharing a data model](#) or some static resources.

18.1 Creating and Installing Plugins

Creating Plugins

Creating a Grails plugin is a simple matter of running the command:

```
grails create-plugin [PLUGIN NAME]
```

This will create a plugin project for the name you specify. For example running `grails create-p` project called `example`.

In Grails 3.0 you should consider whether the plugin you create requires a web environment or whether the plugin does not require a web environment then use the "plugin" profile instead of the "web-plugin" profile

```
grails create-plugin [PLUGIN NAME] --profile=plugin
```

Make sure the plugin name does not contain more than one capital letter in a row, or it won't work. Camel

The structure of a Grails plugin is very nearly the same as a Grails application project's except that in the `src` package structure you will find a plugin descriptor class (a class that ends in "GrailsPlugin").

Being a regular Grails project has a number of benefits in that you can immediately test your plugin by run

```
grails run-app
```



Plugin projects don't provide an `index.gsp` by default since most plugins don't need it. So, running in a browser right after creating it, you will receive a page not found error `grails-app/views/index.gsp` for your plugin if you'd like.

The plugin descriptor name ends with the convention `GrailsPlugin` and is found in the root of the plug

```
class ExampleGrailsPlugin {  
    ...  
}
```

All plugins must have this class under the `src/main/groovy` directory, otherwise they are not regarded about the plugin, and optionally various hooks into plugin extension points (covered shortly).

You can also provide additional information about your plugin using several special properties:

- `title` - short one-sentence description of your plugin
- `grailsVersion` - The version range of Grails that the plugin supports. eg. `"1.2 > *"` (indicating 1.2
- `author` - plugin author's name
- `authorEmail` - plugin author's contact e-mail
- `description` - full multi-line description of plugin's features
- `documentation` - URL of the plugin's documentation
- `license` - License of the plugin
- `issueManagement` - Issue Tracker of the plugin
- `scm` - Source code management location of the plugin

Here is an example from the [Quartz Grails plugin](#):

```

class QuartzGrailsPlugin {
    def grailsVersion = "1.1 > *"
    def author = "Sergey Nebolsin"
    def authorEmail = "nebolsin@gmail.com"
    def title = "Quartz Plugin"
    def description = '''\
The Quartz plugin allows your Grails application to schedule jobs\
to be executed using a specified interval or cron expression. The\
underlying system uses the Quartz Enterprise Job Scheduler configured\
via Spring, but is made simpler by the coding by convention paradigm.\
'''
    def documentation = "http://grails.org/plugin/quartz"

    ...
}

```

Installing Local Plugins

To make your plugin available for use in a Grails application run the `install` command:

```
grails install
```

This will install the plugin into your local Maven cache. Then to use the plugin within an application `build.gradle` file:

```
compile "org.grails.plugins:quartz:0.1"
```



In Grails 2.x plugins were packaged as ZIP files, however in Grails 3.x plugins are simple JAR files added to the classpath of the IDE.

Plugins and Multi-Project Builds

If you wish to setup a plugin as part of a multi project build then follow these steps.

Step 1: Create the application and the plugin

Using the `grails` command create an application and a plugin:

```
$ grails create-app myapp
$ grails create-app myplugin
```

Step 2: Create a settings.gradle file

In the same directory create a `settings.gradle` file with the following contents:

```
include "myapp", "myplugin"
```

The directory structure should be as follows:

```
PROJECT_DIR
- settings.gradle
- myapp
  - build.gradle
- myplugin
  - build.gradle
```

Step 3: Declare a project dependency on the plugin

Within the `build.gradle` of the application declare a dependency on the plugin within the `plugins` block

```
grails {
    plugins {
        compile project(':myplugin')
    }
}
```



You can also declare the dependency within the `dependencies` block, however you will not be able to do this!

Step 4: Run the application

Now run the application using the `grails run-app` command from the root of the application directory. The Gradle output:

```
$ cd myapp
$ grails run-app -verbose
```

You will notice from the Gradle output that plugin sources are built and placed on the classpath of your application.

```
:myplugin:compileAstJava UP-TO-DATE
:myplugin:compileAstGroovy UP-TO-DATE
:myplugin:processAstResources UP-TO-DATE
:myplugin:astClasses UP-TO-DATE
:myplugin:compileJava UP-TO-DATE
:myplugin:configScript UP-TO-DATE
:myplugin:compileGroovy
:myplugin:copyAssets UP-TO-DATE
:myplugin:copyCommands UP-TO-DATE
:myplugin:copyTemplates UP-TO-DATE
:myplugin:processResources
:myapp:compileJava UP-TO-DATE
:myapp:compileGroovy
:myapp:processResources UP-TO-DATE
:myapp:classes
:myapp:findMainClass
:myapp:bootRun
Grails application running at http://localhost:8080 in environment: development
```

Notes on excluded Artefacts

Although the [create-plugin](#) command creates certain files for you so that the plugin can be run as a Grails application, when packaging a plugin. The following is a list of artefacts created, but not included by [package-plugin](#):

- `grails-app/build.gradle` (although it is used to generate dependencies.groovy)
- `grails-app/conf/application.yml` (renamed to `plugin.yml`)
- `grails-app/conf/spring/resources.groovy`
- `grails-app/conf/logback.groovy`
- Everything within `/src/test/**`
- SCM management files within `**/.svn/**` and `**/CVS/**`

Customizing the plugin contents

When developing a plugin you may create test classes and sources that are used during the development but are not exported to the application.

To exclude test sources you need to modify the `pluginExcludes` property of the plugin descriptor `build.gradle` file. For example say you have some classes under the `com.demo` package that are packaged in the application. In your plugin descriptor you should exclude these:

```
// resources that should be loaded by the plugin once installed in the application
def pluginExcludes = [
    '**/com/demo/**'
]
```

And in your `build.gradle` you should exclude the compiled classes from the JAR file:

```
jar {
    exclude "com/demo/**/*"
}
```

Inline Plugins in Grails 3.0

In Grails 2.x it was possible to specify inline plugins in `BuildConfig`, in Grails 3.x this functionality has been removed.

To set up a multi project build create an application and a plugin in a parent directory:

```
$ grails create-app myapp
$ grails create-plugin myplugin
```

Then create a `settings.gradle` file in the parent directory specifying the location of your application and plugin:

```
include 'myapp', 'myplugin'
```

Finally add a dependency in your application's `build.gradle` on the plugin:

```
compile project(':myplugin')
```

Using this technique you have achieved the equivalent of inline plugins from Grails 2.x.

18.2 Plugin Repositories

Distributing Plugins in the Grails Central Plugin Repository

The preferred way to distribute plugin is to publish to the official Grails Central Plugin Repository. This command:

```
grails list-plugins
```

which lists all plugins that are in the central repository. Your plugin will also be available to the [plugin-info](#)

```
grails plugin-info [plugin-name]
```

which prints extra information about it, such as its description, who wrote, etc.



If you have created a Grails plugin and want it to be hosted in the central repository, you'll first need to create an account on the [plugin portal](#) website.

18.3 Providing Basic Artefacts

Add Command Line Commands

A plugin can add new commands to the Grails 3.0 interactive shell in one of two ways. First, using the `create-script` command which will become available to the application. The `create-script` command will create the script

```
+ src/main/scripts      <-- additional scripts here
+ grails-app
  + controllers
  + services
  + etc.
```

Code generation scripts can be used to create artefacts within the project tree and automate interactions with

If you want to create a new shell command that interacts with a loaded Grails application instance command:

```
$ grails create-command MyExampleCommand
```

This will create a file called `grails-app/commands/PACKAGE_PATH/MyExampleCommand.gr`

```
import grails.dev.commands.*
class MyExampleCommand implements ApplicationCommand {
  boolean handle(ExecutionContext ctx) {
    println "Hello World"
    return true
  }
}
```

An `ApplicationCommand` has access to the `GrailsApplication` instance and is subject to autowiring

For each `ApplicationCommand` present Grails will create a shell command and a Gradle task to invoke. For example you can invoke the `MyExampleCommand` class using either:

```
$ grails my-example
```

Or

```
$ gradle myExample
```

The Grails version is all lower case hyphen separated and excludes the "Command" suffix.

The main difference between code generation scripts and `ApplicationCommand` instances is that the state and hence can be used to perform tasks that interactive with the database, call into GORM etc.

In Grails 2.x Gant scripts could be used to perform both these tasks, in Grails 3.x code generation and interactive tasks are cleanly separated.

Adding a new grails-app artifact (Controller, Tag Library, Service, etc.)

A plugin can add new artifacts by creating the relevant file within the `grails-app` tree.

```
+ grails-app
+ controllers <-- additional controllers here
+ services <-- additional services here
+ etc. <-- additional XXX here
```

Providing Views, Templates and View resolution

When a plugin provides a controller it may also provide default views to be rendered. This is an excellent use of plugins. Grails' view resolution mechanism will first look for the view in the application it is installed into, then within the plugin. This means that you can override views provided by a plugin by creating a `grails-app/views` directory.

For example, consider a controller called `BookController` that's provided by an 'amazon' plugin. If the controller looks for a view called `grails-app/views/book/list.gsp` then if that fails it will look for the same view in the plugin.

However if the view uses templates that are also provided by the plugin then the following syntax may be used:

```
<g:render template="fooTemplate" plugin="amazon"/>
```

Note the usage of the `plugin` attribute, which contains the name of the plugin where the template resides, relative to the application.

Excluded Artefacts

By default Grails excludes the following files during the packaging process:

- `grails-app/conf/logback.groovy`
- `grails-app/conf/application.yml` (renamed to `plugin.yml`)
- `grails-app/conf/spring/resources.groovy`
- Everything within `/src/test/**`
- SCM management files within `**/.svn/**` and `**/CVS/**`

In addition, the default `UrlMappings.groovy` file is excluded to avoid naming conflicts, however you can specify a different name which **will** be included. For example a file called `grails-app/controllers/Blog`

The list of excludes is extensible with the `pluginExcludes` property:

```
// resources that are excluded from plugin packaging
def pluginExcludes = [
    "grails-app/views/error.gsp"
]
```

This is useful for example to include demo or test resources in the plugin repository, but not include them in the application.

18.4 Evaluating Conventions

Before looking at providing runtime configuration based on conventions you first need to understand how. Every plugin has an implicit `application` variable which is an instance of the [GrailsApplication](#) interface.

The `GrailsApplication` interface provides methods to evaluate the conventions within the project classes within your application.

Artifacts implement the [GrailsClass](#) interface, which represents a Grails resource such as a controller. Here are some `GrailsClass` instances you can do:

```
for (grailsClass in application.allClasses) {
    println grailsClass.name
}
```

`GrailsApplication` has a few "magic" properties to narrow the type of artefact you are interested in.

```
for (controllerClass in application.controllerClasses) {
    println controllerClass.name
}
```

The dynamic method conventions are as follows:

- `*Classes` - Retrieves all the classes for a particular artefact name. For example `application.controllerClasses`
- `get*Class` - Retrieves a named class for a particular artefact name. For example `application.getControllerClass("PersonController")`
- `is*Class` - Returns true if the given class is of the given type. For example `application.isControllerClass(PersonController)`

The `GrailsClass` interface has a number of useful methods that let you further evaluate and work with

- `getPropertyValue` - Gets the initial value of the given property on the class
- `hasProperty` - Returns true if the class has the specified property
- `newInstance` - Creates a new instance of this class.
- `getName` - Returns the logical name of the class in the application without the trailing convention postfix
- `getShortName` - Returns the short name of the class without package prefix
- `getFullName` - Returns the full name of the class in the application with the trailing convention postfix
- `getPropertyName` - Returns the name of the class as a property name
- `getLogicalPropertyName` - Returns the logical property name of the class in the application without the trailing convention postfix
- `getNaturalName` - Returns the name of the property in natural terms (e.g. 'lastName' becomes 'Last Name')
- `getPackageName` - Returns the package name

For a full reference refer to the [javadoc API](#).

18.5 Hooking into Runtime Configuration

Grails provides a number of hooks to leverage the different parts of the system and perform runtime configuration.

Hooking into the Grails Spring configuration

First, you can hook in Grails runtime configuration overriding the `doWithSpring` method from the [Platform](#) module. For example the following snippet is from one of the core Grails plugins that provides [initialization](#):

```

import org.springframework.web.servlet.i18n.CookieLocaleResolver
import org.springframework.web.servlet.i18n.LocaleChangeInterceptor
import org.springframework.context.support.ReloadableResourceBundleMessageSource
import grails.plugins.*

class I18nGrailsPlugin extends Plugin {
    def version = "0.1"

    Closure doWithSpring() {{->
        messageSource(ReloadableResourceBundleMessageSource) {
            basename = "WEB-INF/grails-app/i18n/messages"
        }
        localeChangeInterceptor(LocaleChangeInterceptor) {
            paramName = "lang"
        }
        localeResolver(CookieLocaleResolver)
    }}
}

```

This plugin configures the Grails messageSource bean and a couple of other beans to manage Localized Messages using the [Bean Builder](#) syntax to do so.

Customizing the Servlet Environment

In previous versions of Grails it was possible to dynamically modify the generated web.xml. In Grails 3.0 it is no longer possible to programmatically modify the web.xml file anymore.

However, it is possible to perform the most common tasks of modifying the Servlet environment in Grails.

Adding New Servlets

If you want to add a new Servlet instance the simplest way is simply to define a new Spring bean in the configuration file.

```

Closure doWithSpring() {{->
    myServlet(MyServlet)
}}

```

If you need to customize the servlet you can use Spring Boot's [ServletRegistrationBean](#):


```
Closure doWithSpring() {{->
  myServlet(ServletRegistrationBean, new MyServlet(), "/myServlet/*") {
    loadOnStartup = 2
  }
}}
```

Adding New Servlet Filters

Just like Servlets, the simplest way to configure a new filter is to simply define a Spring bean:

```
Closure doWithSpring() {{->
  myFilter(MyFilter)
}}
```

However, if you want to control the order of filter registrations you will need to use Spring Boot's [FilterRe](#)

```
myFilter(FilterRegistrationBean) {
  filter = bean(MyFilter)
  urlPatterns = ['/*']
  order = Ordered.HIGHEST_PRECEDENCE
}
```



Grails' internal registered filters (GrailsWebRequestFilter, HiddenHttpMethod) incrementing HIGHEST_PRECEDENCE by 10 thus allowing several filters to be inserted before.

Doing Post Initialisation Configuration

Sometimes it is useful to be able do some runtime configuration after the Spring [ApplicationContext](#) doWithApplicationContext closure property.

```

class SimplePlugin extends Plugin{
  def name = "simple"
    def version = "1.1"

  @Override
    void doWithApplicationContext() {
      def sessionFactory = applicationContext.sessionFactory
      // do something here with session factory
    }
}

```

18.6 Adding Methods at Compile Time

Grails 3.0 makes it easy to add new traits to existing artefact types from a plugin. For example say you want to add a trait to controllers. This can be done by defining a trait in `src/main/groovy`:

```

package myplugin

@Enhances("Controller")
trait DateTrait {
  Date currentDate() {
    return new Date()
  }
}

```

The `@Enhances` annotation defines the types of artefacts that the trait should be applied to.

As an alternative to using the `@Enhances` annotation above, you can implement a [TraitInjector](#) to tell Grails what to inject into at compile time:

```

package myplugin

@CompileStatic
class ControllerTraitInjector implements TraitInjector {

  @Override
    Class getTrait() {
      DateTrait
    }

  @Override
    String[] getArtefactTypes() {
      ['Controller'] as String[]
    }
}

```

The above `TraitInjector` will add the `DateTrait` to all controllers. The `getArtefactTypes` method should be applied to.

18.7 Adding Dynamic Methods at Runtime

The Basics

Grails plugins let you register dynamic methods with any Grails-managed or other class at runtime. This is done by implementing the `doWithDynamicMethods` method.



Note that Grails 3.x features newer features such as traits that are usable from code compiled at runtime. It is recommended that dynamic behavior is only added for cases that are not possible with traits.

```
class ExamplePlugin extends Plugin {
    void doWithDynamicMethods() {
        for (controllerClass in grailsApplication.controllerClasses) {
            controllerClass.metaClass.myNewMethod = { -> println "hello world" }
        }
    }
}
```

In this case we use the implicit application object to get a reference to all of the controller classes' `MetaClass`. We then add `myNewMethod` to each controller. If you know beforehand the class you wish to add a method to you can do so directly.

For example we can add a new method `swapCase` to `java.lang.String`:

```
class ExamplePlugin extends Plugin {
    @Override
    void doWithDynamicMethods() {
        String.metaClass.swapCase = { ->
            def sb = new StringBuilder()
            delegate.each {
                sb << (Character.isUpperCase(it as char) ?
                    Character.toLowerCase(it as char) :
                    Character.toUpperCase(it as char))
            }
            sb.toString()
        }
        assert "UpAndDown" == "uPaNDdOWN".swapCase()
    }
}
```

Interacting with the ApplicationContext

The `doWithDynamicMethods` closure gets passed the Spring `ApplicationContext` instance. T within it. For example if you were implementing a method to interact with Hibernate you could use the `SessionFactory` to create a `HibernateTemplate`:

```
import org.springframework.orm.hibernate3.HibernateTemplate

class ExampleHibernatePlugin extends Plugin{
  void doWithDynamicMethods() {
    for (domainClass in grailsApplication.domainClasses) {
      domainClass.metaClass.static.load = { Long id->
        def sf = applicationContext.sessionFactory
        def template = new HibernateTemplate(sf)
        template.load(delegate, id)
      }
    }
  }
}
```

Also because of the autowiring and dependency injection capability of the Spring container you can implement the application context to wire dependencies into your object at runtime:

```
class MyConstructorPlugin {
  void doWithDynamicMethods()
    for (domainClass in grailsApplication.domainClasses) {
      domainClass.metaClass.constructor = {->
        return applicationContext.getBean(domainClass.name)
      }
    }
}
```

Here we actually replace the default constructor with one that looks up prototyped Spring beans instead!

18.8 Participating in Auto Reload Events

Monitoring Resources for Changes

Often it is valuable to monitor resources for changes and perform some action when they occur. This is often used to update the application state at runtime. For example, consider this simplified snippet from the `Grails ServicesPlugin`:

```

class ServicesGrailsPlugin extends Plugin {
    ...
    def watchedResources = "file:./grails-app/services/*Service.groovy"
    ...
    void onChange( Map<String, Object> event) {
        if (event.source) {
            def serviceClass = grailsApplication.addServiceClass(event.source)
            def serviceName = "${serviceClass.propertyName}"
            beans {
                "$serviceName"(serviceClass.getClazz()) { bean ->
                    bean.automate = true
                }
            }
        }
    }
}

```

First it defines `watchedResources` as either a String or a List of strings that contain either the referenced watched resources specify a Groovy file, when it is changed it will automatically be reloaded and passed the event object.

The event object defines a number of useful properties:

- `event.source` - The source of the event, either the reloaded Class or a Spring Resource
- `event.ctx` - The Spring ApplicationContext instance
- `event.plugin` - The plugin object that manages the resource (usually this)
- `event.application` - The GrailsApplication instance
- `event.manager` - The GrailsPluginManager instance

These objects are available to help you apply the appropriate changes based on what changed. In the "ServicesGrailsPlugin" it is re-registered with the ApplicationContext when one of the service classes changes.

Influencing Other Plugins

In addition to reacting to changes, sometimes a plugin needs to "influence" another.

Take for example the Services and Controllers plugins. When a service is reloaded, unless you reload the controllers, it will try to auto-wire the reloaded service into an older controller Class.

To get around this, you can specify which plugins another plugin "influences". This means that when one plugin is reloaded its influenced plugins will also be reloaded. For example consider this snippet from the ServicesGrailsPlugin:

```

def influences = ['controllers']

```

Observing other plugins

If there is a particular plugin that you would like to observe for changes but not necessary watch the resource property:

```
def observe = ["controllers"]
```

In this case when a controller is changed you will also receive the event chained from the controllers plugin.

It is also possible for a plugin to observe all loaded plugins by using a wildcard:

```
def observe = ["*"]
```

The Logging plugin does exactly this so that it can add the `log` property back to *any* artefact that changes.

18.9 Understanding Plugin Load Order

Controlling Plugin Dependencies

Plugins often depend on the presence of other plugins and can adapt depending on the presence of others. The first is called `dependsOn`. For example, take a look at this snippet from the Hibernate plugin:

```
class HibernateGrailsPlugin {
  def version = "1.0"
  def dependsOn = [dataSource: "1.0",
                  domainClass: "1.0",
                  i18n: "1.0",
                  core: "1.0"]
}
```

The Hibernate plugin is dependent on the presence of four plugins: the `dataSource`, `domainClass`, `i18n`, and `core`.

The dependencies will be loaded before the Hibernate plugin and if all dependencies do not load, then the plugin will not load.

The `dependsOn` property also supports a mini expression language for specifying version ranges. A few examples:

```
def dependsOn = [foo: "* > 1.0"]
def dependsOn = [foo: "1.0 > 1.1"]
def dependsOn = [foo: "1.0 > *"]
```

When the wildcard `*` character is used it denotes "any" version. The expression syntax also excludes an example the expression `"1.0 > 1.1"` would match any of the following versions:

- 1.1
- 1.0
- 1.0.1
- 1.0.3-SNAPSHOT
- 1.1-BETA2

Controlling Load Order

Using `dependsOn` establishes a "hard" dependency in that if the dependency is not resolved, the plugin v to have a weaker dependency using the `loadAfter` and `loadBefore` properties:

```
def loadAfter = ['controllers']
```

Here the plugin will be loaded after the `controllers` plugin if it exists, otherwise it will just be loaded the other plugin, for example the Hibernate plugin has this code in its `doWithSpring` closure:

```
if (manager?.hasGrailsPlugin("controllers")) {
    openSessionInViewInterceptor(OpenSessionInViewInterceptor) {
        flushMode = HibernateAccessor.FLUSH_MANUAL
        sessionFactory = sessionFactory
    }
    grailsUrlHandlerMapping.interceptors << openSessionInViewInterceptor
}
```

Here the Hibernate plugin will only register an `OpenSessionInViewInterceptor` if the `contro` variable is an instance of the [GrailsPluginManager](#) interface and it provides methods to interact with other

You can also use the `loadBefore` property to specify one or more plugins that your plugin should load t

```
def loadBefore = ['rabbitmq']
```

Scopes and Environments

It's not only plugin load order that you can control. You can also specify which environments your plugin (a build). Simply declare one or both of these properties in your plugin descriptor:

```
def environments = ['development', 'test', 'myCustomEnv']  
def scopes = [excludes:'war']
```

In this example, the plugin will only load in the 'development' and 'test' environments. Nor will it be packaged from the 'war' phase. This allows development-only plugins to not be packaged for production use.

The full list of available scopes are defined by the enum [BuildScope](#), but here's a summary:

- `test` - when running tests
- `functional-test` - when running functional tests
- `run` - for `run-app` and `run-war`
- `war` - when packaging the application as a WAR file
- `all` - plugin applies to all scopes (default)

Both properties can be one of:

- a string - a sole inclusion
- a list - a list of environments or scopes to include
- a map - for full control, with 'includes' and/or 'excludes' keys that can have string or list values

For example,

```
def environments = "test"
```

will only include the plugin in the test environment, whereas


```
def environments = ["development", "test"]
```

will include it in both the development *and* test environments. Finally,

```
def environments = [includes: ["development", "test"]]
```

will do the same thing.

18.10 The Artefact API

You should by now understand that Grails has the concept of artefacts: special types of classes that it knows about, such as Groovy and Java classes, for example by enhancing them with extra properties and methods. Examples of artefacts include [Grails controllers](#) and [Grails services](#). What you may not be aware of is that Grails allows application and plugin developers access to the underlying Grails infrastructure. You can find out what artefacts are available and even enhance them yourself. You can even provide your own artefacts.

18.10.1 Asking About Available Artefacts

As a plugin developer, it can be important for you to find out about what domain classes, controllers, views, etc. are available in the application. For example, the [Searchable plugin](#) needs to know what domain classes exist so it can check and index the appropriate ones. So how does it do it? The answer lies with the `grailsApplication` object, which is available automatically in controllers and GSPs and can be [injected](#) everywhere else.

The `grailsApplication` object has several important properties and methods for querying artefacts. For example, `grailsApplication.classes` returns you all the classes of a particular artefact type:

```
for (cls in grailsApplication.<artefactType>Classes) {  
    ...  
}
```

In this case, `artefactType` is the property name form of the artefact type. With core Grails you have:

- domain
- controller
- tagLib
- service
- codec
- bootstrap
- urlMappings

So for example, if you want to iterate over all the domain classes, you use:

```
for (cls in grailsApplication.domainClasses) {
    ...
}
```

and for URL mappings:

```
for (cls in grailsApplication.urlMappingsClasses) {
    ...
}
```

You need to be aware that the objects returned by these properties are not instances of [Class](#). Instead, they are instances of `GrailsClass`, which has several useful properties and methods, including one for the underlying `Class`:

- `shortName` - the class name of the artefact without the package (equivalent of `Class.getSimpleName()`)
- `logicalPropertyName` - the artefact name in property form without the 'type' suffix. So `MyGreatController` would be `myGreatController`.
- `isAbstract()` - a boolean indicating whether the artefact class is abstract or not.
- `getPropertyValue(name)` - returns the value of the given property, whether it's a static or an instance property, initialised on declaration, e.g. `static transactional = true`.

The artefact API also allows you to fetch classes by name and check whether a class is an artefact:

- `get<type>Class(String name)`
- `is<type>Class(Class clazz)`

The first method will retrieve the `GrailsClass` instance for the given name, e.g. `MyGreatController` for the particular type of artefact. For example, you can use `grailsApplication.isControllerClass(MyGreatController)` to check whether `MyGreatController` is in fact a controller.

18.10.2 Adding Your Own Artefact Types

Plugins can easily provide their own artefacts so that they can easily find out what implementations are available. To do this, you create an `ArtefactHandler` implementation and register it in your main plugin class:

```
class MyGrailsPlugin {
    def artefacts = [ org.somewhere.MyArtefactHandler ]
    ...
}
```

The `artefacts` list can contain either handler classes (as above) or instances of handlers.

So, what does an artefact handler look like? Well, put simply it is an implementation of the [ArtefactHandler](#) skeleton implementation that can readily be extended: [ArtefactHandlerAdapter](#).

In addition to the handler itself, every new artefact needs a corresponding wrapper class that implements [GrailsArtefactHandler](#), available such as [AbstractInjectableGrailsClass](#), which is particularly useful as it turns your artefact into controllers and services.

The best way to understand how both the handler and wrapper classes work is to look at the Quartz plugin:

- [GrailsJobClass](#)
- [DefaultGrailsJobClass](#)
- [JobArtefactHandler](#)

Another example is the [Shiro plugin](#) which adds a realm artefact.

19 Grails and Spring

This section is for advanced users and those who are interested in how Grails integrates with and builds [plugin developers](#) considering doing runtime configuration Grails.

19.1 The Underpinnings of Grails

Grails is actually a [Spring MVC](#) application in disguise. Spring MVC is the Spring framework's built-in. Spring MVC suffers from some of the same difficulties as frameworks like Struts in terms of its ease of use, for Grails, the perfect framework to build another framework on top of.

Grails leverages Spring MVC in the following areas:

- Basic controller logic - Grails subclasses Spring's [DispatcherServlet](#) and uses it to delegate to Grails [controllers](#)
- Data Binding and Validation - Grails' [validation](#) and [data binding](#) capabilities are built on those provided by Spring
- Runtime configuration - Grails' entire runtime convention based system is wired together by a Spring [ApplicationContext](#)
- Transactions - Grails uses Spring's transaction management in [GORM](#)

In other words Grails has Spring embedded running all the way through it.

The Grails ApplicationContext

Spring developers are often keen to understand how the Grails `ApplicationContext` instance is constructed.

- Grails constructs a parent `ApplicationContext` from the `web-app/WEB-INF/` directory. This `ApplicationContext` configures the [GrailsApplication](#) instance and the [GrailsPluginManager](#).
- Using this `ApplicationContext` as a parent Grails' analyses the conventions with the `GrailsConventionService`. The `GrailsApplication` that is used as the root `ApplicationContext` of the web application.

Configured Spring Beans

Most of Grails' configuration happens at runtime. Each [plugin](#) may configure Spring beans that are registered. For reference as to which beans are configured, refer to the reference guide which describes each of the Grails [plugins](#).

19.2 Configuring Additional Beans

Using the Spring Bean DSL

You can easily register new (or override existing) beans by configuring them in `grails-app/conf/spring` directory. Grails [Spring DSL](#). Beans are defined inside a `beans` property (a Closure):

```
beans = {  
    // beans here  
}
```

As a simple example you can configure a bean with the following syntax:

```
import my.company.MyBeanImpl

beans = {
    myBean(MyBeanImpl) {
        someProperty = 42
        otherProperty = "blue"
    }
}
```

Once configured, the bean can be auto-wired into Grails artifacts and other classes that support `GrailsBootStrap.groovy` and integration tests) by declaring a public field whose name is your bean's name (e.g. `myBean`).

```
class ExampleController {
    def myBean
    ...
}
```

Using the DSL has the advantage that you can mix bean declarations and logic, for example based on the [environment](#).

```
import grails.util.Environment
import my.company.mock.MockImpl
import my.company.MyBeanImpl

beans = {
    switch(Environment.current) {
        case Environment.PRODUCTION:
            myBean(MyBeanImpl) {
                someProperty = 42
                otherProperty = "blue"
            }
            break
        case Environment.DEVELOPMENT:
            myBean(MockImpl) {
                someProperty = 42
                otherProperty = "blue"
            }
            break
    }
}
```

The GrailsApplication object can be accessed with the application variable and can be used to do things):

```
import grails.util.Environment
import my.company.mock.MockImpl
import my.company.MyBeanImpl

beans = {
    if (application.config.my.company.mockService) {
        myBean(MockImpl) {
            someProperty = 42
            otherProperty = "blue"
        }
    } else {
        myBean(MyBeanImpl) {
            someProperty = 42
            otherProperty = "blue"
        }
    }
}
```



If you define a bean in `resources.groovy` with the same name as one previously registered in a plugin, your bean will replace the previous registration. This is a convenient way to customize behavior, but it can be risky. It is better to use editing plugin code or other approaches that would affect maintainability.

Using XML

Beans can also be configured using a `grails-app/conf/spring/resources.xml`. In earlier versions of Grails, this file was generated for you by the `run-app` script, but the DSL in `resources.groovy` is the preferred approach. But it is still supported - you just need to create it yourself.

This file is typical Spring XML file and the Spring documentation has an [excellent reference](#) on how to configure beans.

The `myBean` bean that we configured using the DSL would be configured with this syntax in the XML file:

```
<bean id="myBean" class="my.company.MyBeanImpl">
    <property name="someProperty" value="42" />
    <property name="otherProperty" value="blue" />
</bean>
```

Like the other bean it can be auto-wired into any class that supports dependency injection:

```
class ExampleController {
    def myBean
}
```

Referencing Existing Beans

Beans declared in `resources.groovy` or `resources.xml` can reference other beans by convention. If a bean's Spring bean name would be `bookService`, so your bean would reference it like this in the DSL

```
beans = {
    myBean(MyBeanImpl) {
        someProperty = 42
        otherProperty = "blue"
        bookService = ref("bookService")
    }
}
```

or like this in XML:

```
<bean id="myBean" class="my.company.MyBeanImpl">
    <property name="someProperty" value="42" />
    <property name="otherProperty" value="blue" />
    <property name="bookService" ref="bookService" />
</bean>
```

The bean needs a public setter for the bean reference (and also the two simple properties), which in Groovy

```
package my.company

class MyBeanImpl {
    Integer someProperty
    String otherProperty
    BookService bookService // or just "def bookService"
}
```

or in Java like this:

```
package my.company;

class MyBeanImpl {

    private BookService bookService;
    private Integer someProperty;
    private String otherProperty;

    public void setBookService(BookService theBookService) {
        this.bookService = theBookService;
    }

    public void setSomeProperty(Integer someProperty) {
        this.someProperty = someProperty;
    }

    public void setOtherProperty(String otherProperty) {
        this.otherProperty = otherProperty;
    }
}
```

Using `ref` (in XML or the DSL) is very powerful since it configures a runtime reference, so the reference is in place when the final application context configuration occurs, everything will be resolved correctly.

For a full reference of the available beans see the plugin reference in the reference guide.

19.3 Runtime Spring with the Beans DSL

This Bean builder in Grails aims to provide a simplified way of wiring together dependencies that uses Spring.

In addition, Spring's regular way of configuration (via XML and annotations) is static and difficult to programmatic XML creation which is both error prone and verbose. Grails' [BeanBuilder](#) changes all that together components at runtime, allowing you to adapt the logic based on system properties or environment.

This enables the code to adapt to its environment and avoids unnecessary duplication of code (having different production environments).

The BeanBuilder class

Grails provides a [grails.spring.BeanBuilder](#) class that uses dynamic Groovy to construct bean definitions.]


```

import org.apache.commons.dbcp.BasicDataSource
import org.grails.orm.hibernate.ConfigurableLocalSessionFactoryBean
import org.springframework.context.ApplicationContext
import grails.spring.BeanBuilder

def bb = new BeanBuilder()

bb.beans {

  dataSource(BasicDataSource) {
    driverClassName = "org.h2.Driver"
    url = "jdbc:h2:mem:grailsDB"
    username = "sa"
    password = ""
  }

  sessionFactory(ConfigurableLocalSessionFactoryBean) {
    dataSource = ref('dataSource')
    hibernateProperties = ["hibernate.hbm2ddl.auto": "create-drop",
                        "hibernate.show_sql": "true"]
  }
}

ApplicationContext appContext = bb.createApplicationContext()

```



Within [plugins](#) and the [grails-app/conf/spring/resources.groovy](#) file you don't need to use BeanBuilder. Instead the DSL is implicitly available inside the `doWithSpring` and `bean` methods.

This example shows how you would configure Hibernate with a data source with the BeanBuilder class.

Each method call (in this case `dataSource` and `sessionFactory` calls) maps to the name of the bean, whilst the last argument is a block. Within the body of the block you can set properties on the bean's class.

Bean references are resolved automatically using the name of the bean. This can be seen in the example above where `dataSource` resolves the `dataSource` reference.

Certain special properties related to bean management can also be set by the builder, as seen in the following example.

```

sessionFactory(ConfigurableLocalSessionFactoryBean) { bean ->
  // Autowiring behaviour. The other option is 'byType'. [autowire]
  bean.autowire = 'byName'
  // Sets the initialisation method to 'init'. [init-method]
  bean.initMethod = 'init'
  // Sets the destruction method to 'destroy'. [destroy-method]
  bean.destroyMethod = 'destroy'
  // Sets the scope of the bean. [scope]
  bean.scope = 'request'
  dataSource = ref('dataSource')
  hibernateProperties = ["hibernate.hbm2ddl.auto": "create-drop",
                      "hibernate.show_sql": "true"]
}

```

The strings in square brackets are the names of the equivalent bean attributes in Spring's XML definition.

Using BeanBuilder with Spring MVC

Include the `grails-spring-<version>.jar` file in your classpath to use BeanBuilder in a re following `<context-param>` values to your `/WEB-INF/web.xml` file:

```
<context-param>
  <param-name>contextConfigLocation</param-name>
  <param-value>/WEB-INF/applicationContext.groovy</param-value>
</context-param>

<context-param>
  <param-name>contextClass</param-name>
  <param-value>
    grails.web.servlet.context.GrailsWebApplicationContext
  </param-value>
</context-param>
```

Then create a `/WEB-INF/applicationContext.groovy` file that does the rest:

```
import org.apache.commons.dbcp.BasicDataSource

beans {
  dataSource(BasicDataSource) {
    driverClassName = "org.h2.Driver"
    url = "jdbc:h2:mem:grailsDB"
    username = "sa"
    password = ""
  }
}
```

Loading Bean Definitions from the File System

You can use the BeanBuilder class to load external Groovy scripts that define beans using the same pat

```
def bb = new BeanBuilder()
bb.loadBeans("classpath:*SpringBeans.groovy")

def applicationContext = bb.createApplicationContext()
```

Here the BeanBuilder loads all Groovy files on the classpath ending with `SpringBeans.groo` example script can be seen below:

```
import org.apache.commons.dbcp.BasicDataSource
import org.grails.orm.hibernate.ConfigurableLocalSessionFactoryBean

beans {

  dataSource(BasicDataSource) {
    driverClassName = "org.h2.Driver"
    url = "jdbc:h2:mem:grailsDB"
    username = "sa"
    password = ""
  }

  sessionFactory(ConfigurableLocalSessionFactoryBean) {
    dataSource = dataSource
    hibernateProperties = [ "hibernate.hbm2ddl.auto": "create-drop",
                          "hibernate.show_sql": "true" ]
  }
}
```

Adding Variables to the Binding (Context)

If you're loading beans from a script you can set the binding to use by creating a Groovy Binding:

```
def binding = new Binding()
binding.maxSize = 10000
binding.productGroup = 'finance'

def bb = new BeanBuilder()
bb.binding = binding
bb.loadBeans("classpath:*SpringBeans.groovy")

def ctx = bb.createApplicationContext()
```

Then you can access the `maxSize` and `productGroup` properties in your DSL files.

19.4 The BeanBuilder DSL Explained

Using Constructor Arguments

Constructor arguments can be defined using parameters to each bean-defining method. Put them after the f

```
bb.beans {
  exampleBean(MyExampleBean, "firstArgument", 2) {
    someProperty = [1, 2, 3]
  }
}
```

This configuration corresponds to a `MyExampleBean` with a constructor that looks like this:

```
MyExampleBean(String foo, int bar) {
  ...
}
```

Configuring the BeanDefinition (Using factory methods)

The first argument to the closure is a reference to the bean configuration instance, which you can use to call on the [AbstractBeanDefinition](#) class:

```
bb.beans {
  exampleBean(MyExampleBean) { bean ->
    bean.factoryMethod = "getInstance"
    bean.singleton = false
    someProperty = [1, 2, 3]
  }
}
```

As an alternative you can also use the return value of the bean defining method to configure the bean:

```
bb.beans {
  def example = exampleBean(MyExampleBean) {
    someProperty = [1, 2, 3]
  }
  example.factoryMethod = "getInstance"
}
```

Using Factory beans

Spring defines the concept of factory beans and often a bean is created not directly from a new instance of a class. In this case the bean has no Class argument and instead you must pass the name of the factory bean to the bean definition.

```
bb.beans {
  myFactory(ExampleFactoryBean) {
    someProperty = [1, 2, 3]
  }
  myBean(myFactory) {
    name = "blah"
  }
}
```

Another common approach is to provide the name of the factory method to call on the factory bean. This is the syntax:

```
bb.beans {
  myFactory(ExampleFactoryBean) {
    someProperty = [1, 2, 3]
  }
  myBean(myFactory: "getInstance") {
    name = "blah"
  }
}
```

Here the `getInstance` method on the `ExampleFactoryBean` bean will be called to create the `myBean`.

Creating Bean References at Runtime

Sometimes you don't know the name of the bean to be created until runtime. In this case you can use the `ref` method dynamically:

```
def beanName = "example"
bb.beans {
  "${beanName}Bean"(MyExampleBean) {
    someProperty = [1, 2, 3]
  }
}
```

In this case the `beanName` variable defined earlier is used when invoking a bean defining method. The code just as well with a name that is generated programmatically based on configuration, system properties, etc.

Furthermore, because sometimes bean names are not known until runtime you may need to reference them in this case using the `ref` method:

```
def beanName = "example"
bb.beans {
  "${beanName}Bean"(MyExampleBean) {
    someProperty = [1, 2, 3]
  }
  anotherBean(AnotherBean) {
    example = ref("${beanName}Bean")
  }
}
```

Here the `example` property of `AnotherBean` is set using a runtime reference to the `exampleBean`. This is done from a parent `ApplicationContext` that is provided in the constructor of the `BeanBuilder`:

```
ApplicationContext parent = ...//
def bb = new BeanBuilder(parent)
bb.beans {
  anotherBean(AnotherBean) {
    example = ref("${beanName}Bean", true)
  }
}
```

Here the second parameter `true` specifies that the reference will look for the bean in the parent context.

Using Anonymous (Inner) Beans

You can use anonymous inner beans by setting a property of the bean to a block that takes an argument that

```

bb.beans {
  marge(Person) {
    name = "Marge"
    husband = { Person p ->
      name = "Homer"
      age = 45
      props = [overweight: true, height: "1.8m"]
    }
    children = [ref('bart'), ref('lisa')]
  }
  bart(Person) {
    name = "Bart"
    age = 11
  }
  lisa(Person) {
    name = "Lisa"
    age = 9
  }
}

```

In the above example we set the marge bean's husband property to a block that creates an inner bean ref you can omit the type and just use the specified bean definition instead to setup the factory:

```

bb.beans {
  personFactory(PersonFactory)
  marge(Person) {
    name = "Marge"
    husband = { bean ->
      bean.factoryBean = "personFactory"
      bean.factoryMethod = "newInstance"
      name = "Homer"
      age = 45
      props = [overweight: true, height: "1.8m"]
    }
    children = [ref('bart'), ref('lisa')]
  }
}

```

Abstract Beans and Parent Bean Definitions

To create an abstract bean definition define a bean without a `Class` parameter:

```
class HolyGrailQuest {
    def start() { println "lets begin" }
}
```

```
class KnightOfTheRoundTable {
    String name
    String leader
    HolyGrailQuest quest
    KnightOfTheRoundTable(String name) {
        this.name = name
    }
    def embarkOnQuest() {
        quest.start()
    }
}
```

```
import grails.spring.BeanBuilder
def bb = new BeanBuilder()
bb.beans {
    abstractBean {
        leader = "Lancelot"
    }
    ...
}
```

Here we define an abstract bean that has a leader property with the value of "Lancelot". To use the bean:


```

bb.beans {
    ...
    quest(HolyGrailQuest)
    knights(KnightOfTheRoundTable, "Camelot") { bean ->
        bean.parent = abstractBean
        quest = ref('quest')
    }
}

```



When using a parent bean you must set the parent property of the bean before setting any other

If you want an abstract bean that has a Class specified you can do it this way:

```

import grails.spring.BeanBuilder
def bb = new BeanBuilder()
bb.beans {
    abstractBean(KnightOfTheRoundTable) { bean ->
        bean.'abstract' = true
        leader = "Lancelot"
    }
    quest(HolyGrailQuest)
    knights("Camelot") { bean ->
        bean.parent = abstractBean
        quest = quest
    }
}

```

In this example we create an abstract bean of type `KnightOfTheRoundTable` and use the bean as the `knights` bean that has no `Class` defined, but inherits the `Class` from the parent bean.

Using Spring Namespaces

Since Spring 2.0, users of Spring have had easier access to key features via XML namespaces. You can declare it with this syntax:

```

xmlns context:"http://www.springframework.org/schema/context"

```

and then invoking a method that matches the names of the Spring namespace tag and its associated attribut

```
context.'component-scan'('base-package': "my.company.domain")
```

You can do some useful things with Spring namespaces, such as looking up a JNDI resource:

```
xmlns jee:"http://www.springframework.org/schema/jee"  
jee.'jndi-lookup'(id: "dataSource", 'jndi-name': "java:comp/env/myDataSource")
```

This example will create a Spring bean with the identifier `dataSource` by performing a JNDI lookup on you also get full access to all of the powerful AOP support in Spring from `BeanBuilder`. For example given

```
class Person {  
    int age  
    String name  
    void birthday() {  
        ++age;  
    }  
}
```

```
class BirthdayCardSender {  
    List peopleSentCards = []  
    void onBirthday(Person person) {  
        peopleSentCards << person  
    }  
}
```

You can define an aspect that uses a pointcut to detect whenever the `birthday()` method is called:

```

xmlns aop:"http://www.springframework.org/schema/aop"

fred(Person) {
    name = "Fred"
    age = 45
}

birthdayCardSenderAspect(BirthdayCardSender)

aop {
    config("proxy-target-class": true) {
        aspect(id: "sendBirthdayCard", ref: "birthdayCardSenderAspect") {
            after method: "onBirthday",
            pointcut: "execution(void ..Person.birthday()) and this(person)"
        }
    }
}

```

19.5 Property Placeholder Configuration

Grails supports the notion of property placeholder configuration through an extended version of Spring's [PropertyPlaceholderConfigurer](#).

Settings defined in either [ConfigSlurper](#) scripts or Java properties files can be used as place holders in `grails-app/conf/spring/resources.xml` and `grails-app/conf/spring/resource` entries in `grails-app/conf/application.groovy` (or an externalized config):

```

database.driver="com.mysql.jdbc.Driver"
database.dbname="mysql:mydb"

```

You can then specify placeholders in `resources.xml` as follows using the familiar `${..}` syntax:

```

<bean id="dataSource"
    class="org.springframework.jdbc.datasource.DriverManagerDataSource">
    <property name="driverClassName">
        <value>${database.driver}</value>
    </property>
    <property name="url">
        <value>jdbc:${database.dbname}</value>
    </property>
</bean>

```

To specify placeholders in `resources.groovy` you need to use single quotes:

```
dataSource(org.springframework.jdbc.datasource.DriverManagerDataSource) {
    driverClassName = '${database.driver}'
    url = 'jdbc:${database.dbname}'
}
```

This sets the property value to a literal string which is later resolved against the config by Spring's PropertyPlaceholderConfigurer. A better option for resources.groovy is to access properties through the grailsApplication variable:

```
dataSource(org.springframework.jdbc.datasource.DriverManagerDataSource) {
    driverClassName = grailsApplication.config.database.driver
    url = "jdbc:${grailsApplication.config.database.dbname}"
}
```

Using this approach will keep the types as defined in your config.

19.6 Property Override Configuration

Grails supports setting of bean properties via [configuration](#).

You define a beans block with the names of beans and their values:

```
beans {
    bookService {
        webServiceURL = "http://www.amazon.com"
    }
}
```

The general format is:

```
[bean name].[property name] = [value]
```

The same configuration in a Java properties file would be:

```
beans.bookService.webServiceURL=http://www.amazon.com
```

20 Grails and Hibernate

If [GORM](#) (Grails Object Relational Mapping) is not flexible enough for your liking you can alternatively use GORM with XML mapping files or JPA annotations. You will be able to map Grails domain classes onto a database schema with flexibility in the creation of your database schema. Best of all, you will still be able to call all of the dynamic methods of GORM!

20.1 Using Hibernate XML Mapping Files

Mapping your domain classes with XML is pretty straightforward. Simply create a `hibernate.cfg.xml` file in the `src/main/resources` directory, either manually or with the [create-hibernate-cfg-xml](#) command, that contains the following:

```
<?xml version='1.0' encoding='UTF-8'?>
<!DOCTYPE hibernate-configuration PUBLIC
    "-//Hibernate/Hibernate Configuration DTD 3.0//EN"
    "http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd">
<hibernate-configuration>
    <session-factory>
        <!-- Example mapping file inclusion -->
        <mapping resource="org.example.Book.hbm.xml"/>
        ...
    </session-factory>
</hibernate-configuration>
```

The individual mapping files, like 'org.example.Book.hbm.xml' in the above example, also go into the `src/main/resources` directory. To learn more about mapping domain classes with XML, check out the [Hibernate manual](#).

If the default location of the `hibernate.cfg.xml` file doesn't suit you, you can change its location in the `grails-app/conf/application.groovy` file:

```
hibernate {
    config.location = "file:/path/to/my/hibernate.cfg.xml"
}
```

or even a list of locations:

```
hibernate {
    config.location = [ "file:/path/to/one/hibernate.cfg.xml",
                       "file:/path/to/two/hibernate.cfg.xml" ]
}
```

Grails also lets you write your domain model in Java or reuse an existing one that already has Hibernate into `grails-app/conf` and either put the Java files in `src/java` or the classes in the project's `lib` JAR. You still need the `hibernate.cfg.xml` though!

20.2 Mapping with Hibernate Annotations

To map a domain class with annotations, create a new class in `src/java` and use the annotations defined there (see the [Hibernate Annotations Docs](#)):

```
package com.books;

import javax.persistence.Entity;
import javax.persistence.GeneratedValue;
import javax.persistence.Id;

@Entity
public class Book {
    private Long id;
    private String title;
    private String description;
    private Date date;

    @Id
    @GeneratedValue
    public Long getId() {
        return id;
    }

    public void setId(Long id) {
        this.id = id;
    }

    public String getTitle() {
        return title;
    }

    public void setTitle(String title) {
        this.title = title;
    }

    public String getDescription() {
        return description;
    }

    public void setDescription(String description) {
        this.description = description;
    }
}
```

Then register the class with the Hibernate `sessionFactory` by adding relevant entries to the `grails` file as follows:

```
<!DOCTYPE hibernate-configuration SYSTEM
"http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd">
<hibernate-configuration>
  <session-factory>
    <mapping package="com.books" />
    <mapping class="com.books.Book" />
  </session-factory>
</hibernate-configuration>
```

See the previous section for more information on the `hibernate.cfg.xml` file.

When Grails loads it will register the necessary dynamic methods with the class. To see what else you section on [Scaffolding](#).

20.3 Adding Constraints

You can still use GORM validation even if you use a Java domain model. Grails lets you define constraints directory. The script must be in a directory that matches the package of the corresponding domain class. For example, if you had a domain class `org.example.Book`, then you would create a file `src/java/org/example/BookConstraints.groovy`.

Add a standard GORM constraints block to the script:

```
constraints = {
  title blank: false
  author blank: false
}
```

Once this is in place you can validate instances of your domain class!

21 Scaffolding

Scaffolding lets you generate some basic CRUD interfaces for a domain class, including:

- The necessary [views](#)
- Controller actions for create/read/update/delete (CRUD) operations

The way for an application to express a dependency on the scaffolding plugin is by including the following

```
dependencies {  
    // ...  
    compile "org.grails.plugins:scaffolding"  
    // ...  
}
```

Dynamic Scaffolding

The simplest way to get started with scaffolding is to enable it by setting the `scaffold` property in the controller.

```
class BookController {  
    static scaffold = Book // Or any other domain class such as "Author", "Publication"  
}
```

With this configured, when you start your application the actions and views will be autogenerated and implemented by default by the runtime scaffolding mechanism:

- index
- show
- edit
- delete
- create
- save
- update

A CRUD interface will also be generated. To access this open `http://localhost:8080/book` in a browser.

Note: The old alternative of defining scaffold property:

```
class BookController {
  static scaffold = true
}
```

is no longer supported above Grails 3.0.

If you prefer to keep your domain model in Java and [mapped with Hibernate](#) you can still use scaffolding, as the scaffold argument.

You can add new actions to a scaffolded controller, for example:

```
class BookController {
  static scaffold = Book

  def changeAuthor() {
    def b = Book.get(params.id)
    b.author = Author.get(params["author.id"])
    b.save()

    // redirect to a scaffolded action
    redirect(action:show)
  }
}
```

You can also override the scaffolded actions:

```
class BookController {
  static scaffold = Book

  // overrides scaffolded action to return both authors and books
  def index() {
    [bookInstanceList: Book.list(),
     bookInstanceTotal: Book.count(),
     authorInstanceList: Author.list()]
  }

  def show() {
    def book = Book.get(params.id)
    log.error(book)
    [bookInstance : book]
  }
}
```

All of this is what is known as "dynamic scaffolding" where the CRUD interface is generated dynamically



By default, the size of text areas in scaffolded views is defined in the CSS, so adding 'rows' has no effect.

Also, the standard scaffold views expect model variables of the form <propertyName>Instance and <propertyName>Instance for single instances. It's tempting to use properties like <propertyName> won't work.

Static Scaffolding

Grails lets you generate a controller and the views used to create the above interface from the command line

```
grails generate-controller Book
```

or to generate the views:

```
grails generate-views Book
```

or to generate everything:

```
grails generate-all Book
```

If you have a domain class in a package or are generating from a [Hibernate mapped class](#) remember to include the package name:

```
grails generate-all com.bookstore.Book
```

Customizing the Generated Views

The views adapt to [Validation constraints](#). For example you can change the order that fields appear in the builder:

```
def constraints = {
  title()
  releaseDate()
}
```

You can also get the generator to generate lists instead of text inputs if you use the `inList` constraint:

```
def constraints = {
  title()
  category(inList: ["Fiction", "Non-fiction", "Biography"])
  releaseDate()
}
```

Or if you use the `range` constraint on a number:

```
def constraints = {
  age(range:18..65)
}
```

Restricting the size with a constraint also effects how many characters can be entered in the d view:

```
def constraints = {
  name(size:0..30)
}
```

Customizing the Scaffolding templates

The templates used by Grails to generate the controller and views can be customized by installing the temp

22 Deployment

Grails applications can be deployed in a number of ways, each of which has its pros and cons.

22.1 Standalone

"grails run-app"

You should be very familiar with this approach by now, since it is the most common method of running a embedded Tomcat server is launched that loads the web application from the development sources, thus a files.

You can also deploy to production this way using:

```
grails prod run-app
```

Runnable WAR or JAR file

Another way to deploy in Grails 3.0 or above is to use the new support for runnable JAR or WAR file package:

```
grails package
```

You can then run either the WAR file or the JAR using your Java installation:

```
java -Dgrails.env=prod -jar build/libs/mywar-0.1.war      (or .jar)
```

A TAR/ZIP distribution

The [package](#) will also produce a TAR and a ZIP file in the build/distributions directory. If you are on Unix systems and the ZIP on Windows) you can then run bash file which is the name of your application located in the build/distributions directory.

For example:

```
$ grails create-app helloworld
$ cd helloworld
$ grails package
$ tar -xvf build/distributions/helloworld-0.1.tar
$ export HELLOWORLD_OPTS=-Dgrails.env=prod
$ helloworld-0.1/bin/helloworld
Grails application running at http://localhost:8080
```



Note: TAR/ZIP distribution assembly has been removed from Grails 3.1.

22.2 Container Deployment (e.g. Tomcat)

Grails apps can be deployed to a Servlet Container or Application Server.

WAR file

A common approach to Grails application deployment in production is to deploy to an existing Servlet Container. Multiple applications can be deployed on the same port with different paths.

Creating a WAR file is as simple as executing the [war](#) command:

```
grails war
```

This will produce a WAR file that can be deployed to a container, in the `build/libs` directory.

Note that by default Grails will include an embeddable version of Tomcat inside the WAR file so that it causes problems if you deploy to a different version of Tomcat. If you don't intend to use the embedded Tomcat dependencies to provide prior to deploying to your production container in `build.gradle`:

```
provided "org.springframework.boot:spring-boot-starter-tomcat"
```

Application servers

Ideally you should be able to simply drop a WAR file created by Grails into any application server and it rarely ever this simple. The [Grails website](#) contains a list of application servers that Grails has been tested get a Grails WAR file working.

22.3 Deployment Configuration Tasks

Setting up HTTPS and SSL certificates for standalone deployment

To configure an SSL certificate and to listen on an HTTPS port instead of HTTP, add properties like these

```
server:
  port: 8443                                # The port to listen on
  ssl:
    enabled: true                           # Activate HTTPS mode
    key-store: <the-location-of-your-keystore> # e.g. /etc/tomcat7/keystore
    key-store-password: <your-key-store-password> # e.g. changeit
    key-alias: <your-key-alias>                # e.g. tomcat
    key-password: <usually-the-same-as-your-key-store-password>
```

These settings control the embedded Tomcat container for a production deployment. Alternatively, the `grails.config.server.ssl.enabled` property can be used. Example: `-Dserver.ssl.enabled=true -Dserver.ssl.key-store=/path/to/keystore`



Configuration of both an HTTP and HTTPS connector via application properties is not supported. If you want to use both, then you'll need to configure one of them programmatically. (More information on how to do this is in the [SSL how-to guide](#) below.)

There are other relevant settings. Further reference:

- [Spring Boot: How to configure SSL on embedded servlet containers](#)
- [Spring Boot: Common Application Properties](#)

23 Contributing to Grails

Grails is an open source project with an active community and we rely heavily on that community to help in ways in which people can contribute to Grails. One of these is by [writing useful plugins](#) and making them some of the other options.

23.1 Report Issues in Github's issue tracker

Grails uses Github to track issues in the [core framework](#). Similarly for its documentation there is a [separate](#) particular feature added, these are the places to start. You'll need to create a (free) github account in or existing one in either of these.

When submitting issues, please provide as much information as possible and in the case of bugs, make sure and various plugins you are using. Other environment details - OS version, JDK, Gradle etc. should also be dealt with if you upload a reproducible sample application on a github repository and provide a link in the

Reviewing issues

There are quite a few old issues in github, some of which may no longer be valid. The core team's contribution that you can make is to verify one or two issues occasionally.

Which issues need verification? Going to the [issue tracker](#) will display all issues that haven't been resolved

Once you've verified an issue, simply add a short comment explaining what you found. Be sure to mention y

23.2 Build From Source and Run Tests

If you're interested in contributing fixes and features to any part of grails, you will have to learn how to get with your own applications. Before you start, make sure you have:

- A JDK (7 or above)
- A git client

Once you have all the pre-requisite packages installed, the next step is to download the Grails source repositories owned by the ["grails" GitHub user](#). This is a simple case of cloning the repository you're interested in:

```
git clone http://github.com/grails/grails-core.git
```

This will create a "grails-core" directory in your current working directory containing all the project installation from the source.

Creating a Grails installation

If you look at the project structure, you'll see that it doesn't look much like a standard `GRAILS_HOME` installation. Just run this from the root directory of the project:


```
./gradlew install
```

This will fetch all the standard dependencies required by Grails and then build a `GRAILS_HOME` installation collection of Grails test classes, which can take some time to complete.

Once the above command has finished, simply set the `GRAILS_HOME` environment variable to the check path. When you next type `grails` command to run, you'll be using the version you just built.

If you are using [SDKMAN](#) then that can also be used to work with this local installation via the following:

```
sdk install grails dev /path/to/grails-core
```

Now you will have a dev version in your local which you can use to test your features.

Running the test suite

All you have to do to run the full suite of tests is:

```
./gradlew test
```

These will take a while (15-30 mins), so consider running individual tests using the command. `BinaryPluginSpec` simply execute the following command:

```
./gradlew :grails-core:test --tests *.BinaryPluginSpec
```

Note that you need to specify the sub-project that the test case resides in, because the top-level "test" target

Developing in IntelliJ IDEA

You need to run the following gradle task:

```
./gradlew idea
```

Then open the project file which is generated in IDEA. Simple!

Developing in STS / Eclipse

You need to run the following gradle task:

```
./gradlew cleanEclipse eclipse
```

Before importing projects to STS do the following action:

- Edit grails-scripts/.classpath and remove the line "<classpathentry kind="src" path="../scripts"/>".

Use "Import->General->Existing Projects into Workspace" to import all projects to STS. There will be a few steps:

- Add the springloaded-core JAR file in \$GRAILS_HOME/lib/org.springframework.springsource.springloaded/springloaded-core.jar
- Remove "src/test/groovy" from grails-plugin-testing's source path GRECLIPSE-1067
- Add the jsp-api JAR file in \$GRAILS_HOME/lib/javax.servlet.jsp/jsp-api/jars to the classpath of grails-core
- Fix the source path of grails-scripts. Add linked source folder linking to "../scripts". If you get an error "cannot find source path" in that directory and edit the .classpath file again (remove the line "<classpathentry kind="src" path="../scripts"/>" if possible empty "scripts" directory under grails-scripts if you are not able to add the linked folder.
- Do a clean build for the whole workspace.
- To use Eclipse GIT scm team provider: Select all projects (except "Servers") in the navigation and right-click on them (or select "Team" -> "Set Team Provider" for all projects). Choose "Git". Then check "Use or create repository in parent folder of project" and click "OK".
- Get the recommended code style settings from the [mailing list thread](#) (final style not decided yet, copy the settings to STS in Window->Preferences->Java->Code Style->Formatter->Import . Grails code uses space for indentation).

Debugging Grails or a Grails application

To enable debugging, run:

```
grails run-app --debug-jvm
```

By default Grails forks a JVM to run the application in. The `-debug-jvm` argument causes the debugger to instead attach the debugger to the build system which is going to fork the JVM use the `-debug` option:

```
grails -debug run-app
```

23.3 Submit Patches to Grails Core

If you want to submit patches to the project, you simply need to fork the repository on GitHub rather than changes to your fork and send a pull request for a core team member to review.

Forking and Pull Requests

One of the benefits of [GitHub](#) is the way that you can easily contribute to a project by [forking the repository](#)

What follows are some guidelines to help ensure that your pull requests are speedily dealt with and provide your life easier!

Make sure your fork is up to date

Making changes to outdated sources is not a good idea. Someone else may have already made the change.

```
git pull upstream master
```

Create a local branch for your changes

Your life will be greatly simplified if you create a local branch to make your changes on. For example, as locally, execute

```
git checkout -b issue_123
```

This will create a new local branch called "issue_123" based off the "master" branch. Of course, you can also have the idea would be to reference the GitHub issue number that the change is relevant to. Each Pull Request should

Create Github issues for non-trivial changes

For any non-trivial changes, raise an issue on github if one doesn't already exist. That helps us keep track of changes in Grails.

Include github issue ID in commit messages

This may not seem particularly important, but having a github issue ID in a commit message means that you can track the changes made. Include the ID in any and all commits that relate to that issue. If a commit isn't related to an issue, then don't include it.

Make sure your fork is up to date again and rebase

Since the core developers must merge your commits into the main repository, it makes life much easier if you always send a pull request.

Let's say you have the main repository set up as a remote called "upstream" and you want to submit a pull request for your changes. The first step involves pulling any changes from the main repository and merging them into your local "issue_123" branch but not on "master". The first step involves pulling any changes from the main repository and merging them into your local "issue_123" branch but not on "master".

```
git checkout master
git pull upstream master
```

This should complete without any problems or conflicts. Next, rebase your local branch against the now up-to-date master branch.

```
git checkout issue_123
git rebase master
```

What this does is rearrange the commits such that all of your changes come after the most recent one in the main repository rather than shuffling them into the pack.

Push your branch to GitHub and send Pull Request

Finally, you must push your changes to your fork on GitHub, otherwise the core developers won't be able to see them.

```
git push origin issue_123
```



You should not merge your branch to your forks master. If the Pull Request is not accepted, you will lose your changes forever.

You're now ready to send the pull request from the GitHub user interface.

Say what your pull request is for

A pull request can contain any number of commits and it may be related to any number of issues. In the pull request, mention the issues that the request relates to. Also give a brief description of the work you have done, such as: "I reworked the custom number editors. Fixes #xxxx".

23.4 Submit Patches to Grails Documentation

Building the Guide

To build the documentation, simply type:

```
./gradlew docs
```

Be warned: this command can take a while to complete and you should probably increase your Gradle heap size by setting the `GRADLE_OPTS` environment variable to a value like

```
export GRADLE_OPTS="-Xmx512m -XX:MaxPermSize=384m"
```

Fortunately, you can reduce the overall build time with a couple of useful options. The first allows you to specify the Grails source directory:

```
./gradlew -Dgrails.home=/home/user/projects/grails-core docs
```

The Grails source is required because the guide links to its API documentation and the build needs to know the location of the `grails.home` property, then the build will fetch the Grails source - a download of 10s of megabytes. It takes a while too.

Additionally you can create a `~/.gradle/gradle.properties` file with this variable set:

```
grails.home=/home/user/projects/grails-core
```

or

```
grails.home=../grails-core
```

The other useful option allows you to disable the generation of the API documentation, since you only need

```
./gradlew -Ddisable.groovydocs=true docs
```

Again, this can save a significant amount of time and memory.

The main English user guide is generated in the `build/docs` directory, with the `guide` sub-directory containing the reference material. To view the user guide, simply open `build/docs/index.html`.

Publishing

The publishing system for the user guide is the same as [the one for Grails projects](#). You write your chapters, which are then converted to HTML for the final guide. Each chapter is a top-level gdoc file in the `src/<lang>/guide` directory. You can then move the gdoc files into directories with the same name as the chapter gdoc but without the suffix.

The structure of the user guide is defined in the `src/<lang>/guide/toc.yml` file, which lists the (language-specific) section titles. If you add or remove a gdoc file, you must update the TOC as well!

The `src/<lang>/ref` directory contains the source for the reference sidebar. Each directory is the name of a class, method, or property. Hence the directories need different names for the different languages. Inside the directories go the gdocs for the methods, commands, properties or whatever that the files describe.

Translations

This project can host multiple translations of the user guide, with `src/en` being the main one. To add a new translation, create a new directory under `src` and copy into it all the files under `src/en`. The build will take care of the rest.

Once you have a copy of the original guide, you can use the `{hidden}` macro to wrap the English text. This makes it easier to compare changes to the English guide against your translation. For example:

```
{hidden}
```

When you create a Grails application with the `[create-app|commandLine]` command, Grails doesn't automatically create an Ant `build.xml` file but you can generate one with the `[integrate-with|commandLine]` command:

```
{hidden}
```

Quando crias uma aplicacao Grails com o comando `[create-app|commandLine]`, Grails no cria automaticamente um ficheiro de construo Ant `build.xml` mas podes gerar um com o comando `[integrate-with|commandLine]`:

Because the English text remains in your gdoc files, `diff` will show differences on the English lines. Yo bits of your translation need updating. On top of that, the `{hidden}` macro ensures that the text inside can display it by adding this URL as a bookmark: `javascript:toggleHidden()`; (requires you later).

Even better, you can use the `left_to_do.groovy` script in the root of the project to see what still need

```
./left_to_do.groovy es
```

This will then print out a recursive diff of the given translation against the reference English user gui changed since being translated will *not* appear in the diff output. In other words, all you will see is conten has changed since it was translated. Note that `{code}` blocks are ignored, so you *don't* need to include the

To provide translations for the headers, such as the user guide title and subtitle, just add language specific so:

```
es.title=El Grails Framework  
es.subtitle=...
```

For each language translation, properties beginning `<lang>.` will override the standard ones. In the above Framework for the Spanish translation. Also, translators can be credited by adding a `'<lang>.translators'` pr

```
fr.translators=Stphane Maldini
```

This should be a comma-separated list of names (or the native language equivalent) and it will be displayed itself.

You can build specific translations very easily using the `publishGuide_*` and `publishPdf_*` tasks and PDF user guides, simply execute

```
./gradlew publishPdf_fr
```

Each translation is generated in its own directory, so for example the French guide will end up in `build/docs/fr/` by opening `build/docs/<lang>/index.html`.

All translations are created as part of the [Hudson CI build for the grails-doc](#) project, so you can easily see the docs yourself.

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